US009651758B2

(12) **United States Patent**
Tang et al.

(10) **Patent No.: US 9,651,758 B2**
(45) **Date of Patent: *May 16, 2017**

(54) **OPTICAL IMAGE CAPTURING SYSTEM**

(71) Applicant: **ABILITY OPTO-ELECTRONICS TECHNOLOGY CO., LTD.**, Taichung (TW)

(72) Inventors: **Nai-Yuan Tang**, Taichung (TW); **Yeong-Ming Chang**, Taichung (TW)

(73) Assignee: **ABILITY OPTO-ELECTRONICS TECHNOLOGY CO., LTD.**, Taichung (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/721,682**

(22) Filed: **May 26, 2015**

(65) **Prior Publication Data**

US 2016/0139365 A1 May 19, 2016

(30) **Foreign Application Priority Data**

Nov. 19, 2014 (TW) .... 103140045 A

(51) **Int. Cl.**
G02B 9/60 (2006.01)
G02B 13/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 13/0045*** (2013.01); ***G02B 9/60*** (2013.01)

(58) **Field of Classification Search**
CPC G02B 9/60; G02B 13/0045
USPC 359/707, 714, 754, 763–769
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0134904 A1* 6/2010 Tsai G02B 9/60 359/764
2013/0050847 A1* 2/2013 Hsu G02B 9/60 359/714
2014/0362454 A1* 12/2014 Tsai G02B 13/004 359/714

FOREIGN PATENT DOCUMENTS

JP 2014123034 A 7/2014
JP 2014206739 A 10/2014
TW 2012237454 A 9/2012

OTHER PUBLICATIONS

Search Report for TW 103140045 dated Sep. 9, 2015, 1 page.

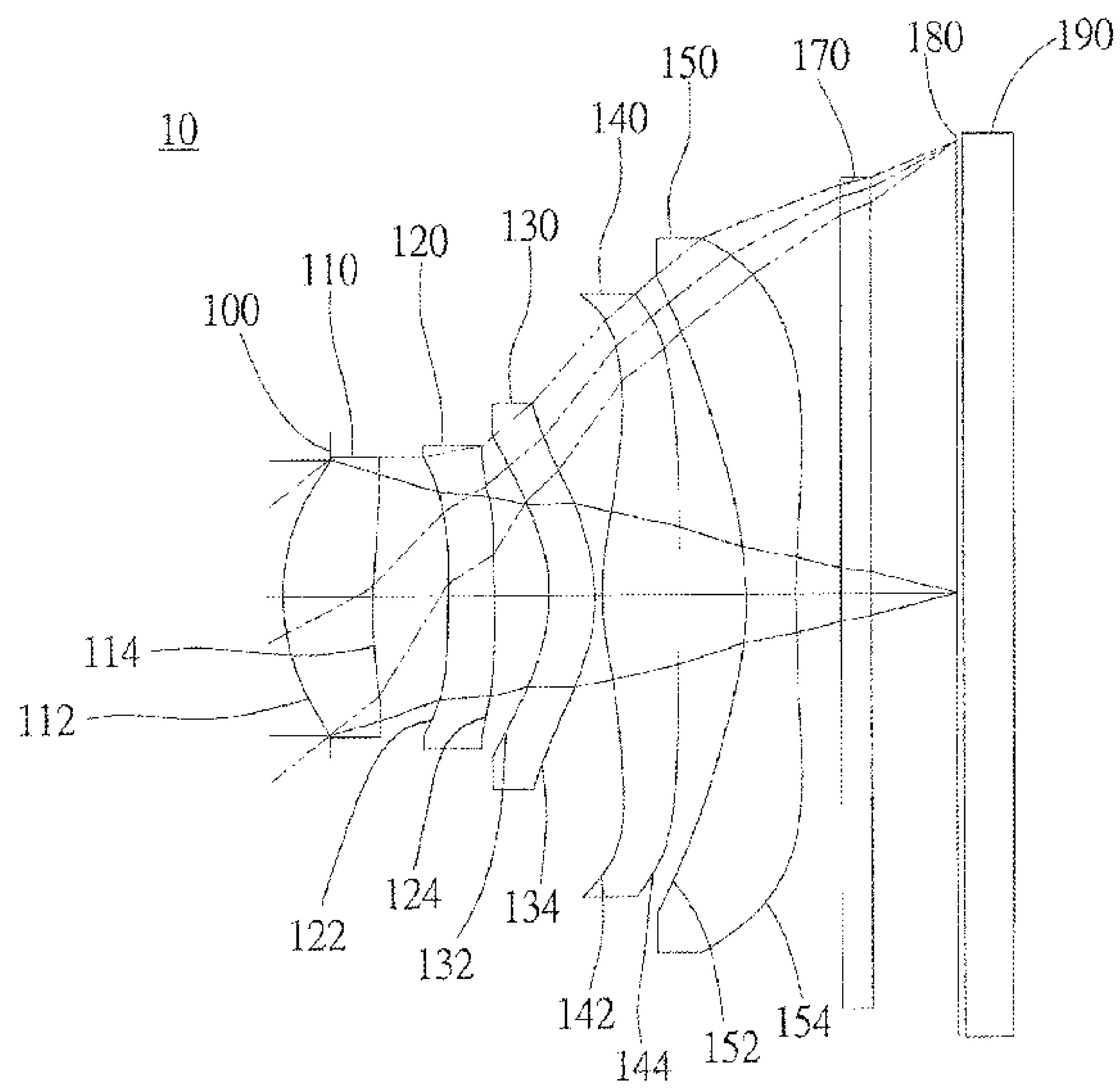
* cited by examiner

Primary Examiner — Darryl J Collins
(74) *Attorney, Agent, or Firm* — Lynette Wylie; Apex Juris, pllc.

(57) **ABSTRACT**

A five-piece optical lens for capturing image and a five-piece optical module for capturing image, along the optical axis in order from an object side to an image side, include a first lens with refractive power having an object-side surface which can be convex; a second lens with refractive power; a third lens with refractive power; a fourth lens with negative refractive power; and a fifth lens which can have negative refractive power, wherein an image-side surface thereof can be concave, and at least one surface of the fifth lens has an inflection point; both surfaces of each of the five lenses are aspheric. The optical lens can increase aperture value and improve the imaging quality for use in compact cameras.

22 Claims, 12 Drawing Sheets



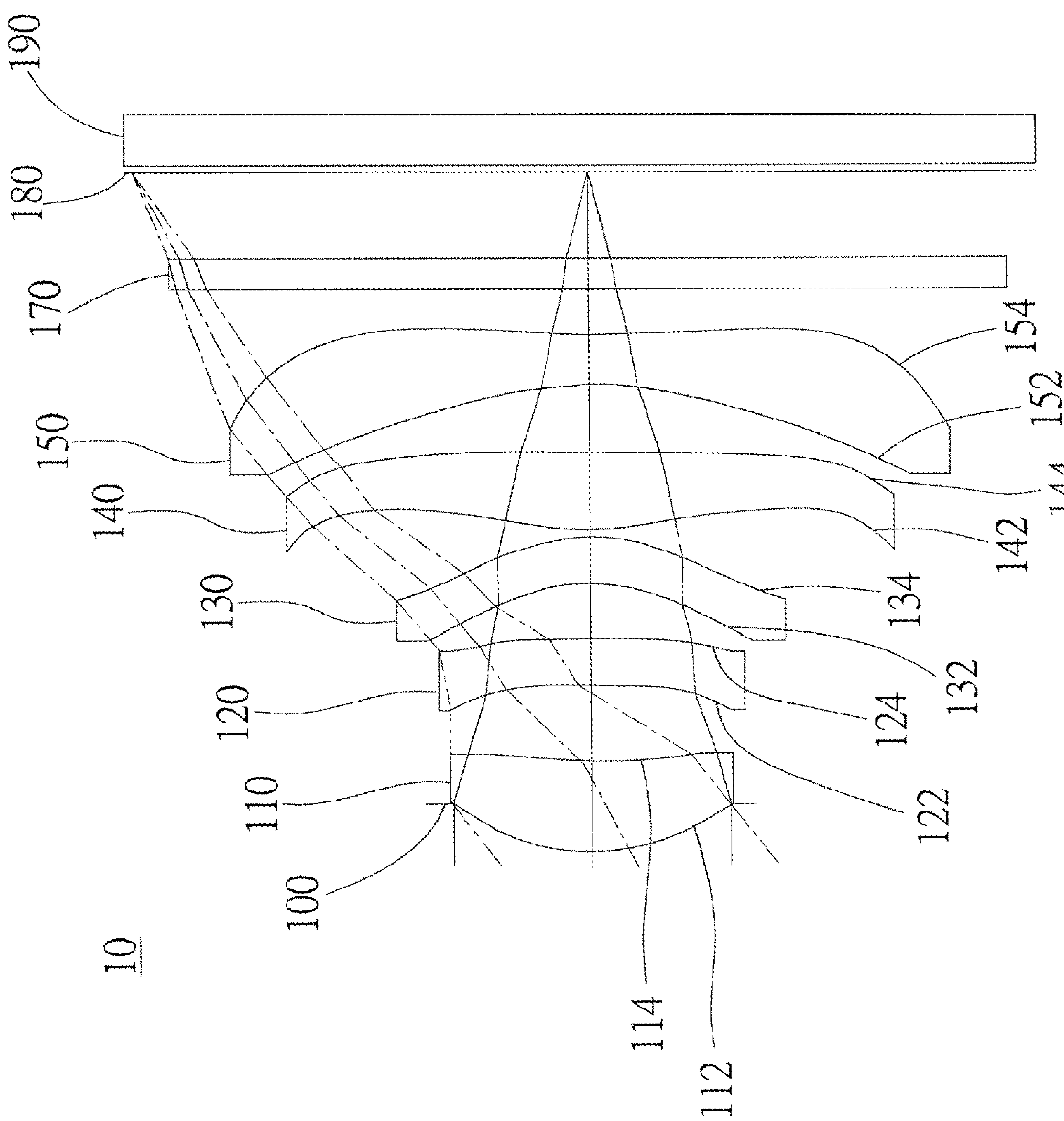

10
100
110
112
114
120
122
124
130
132
134
140
142
144
150
152
154
170
180
190

FIG. 1 A

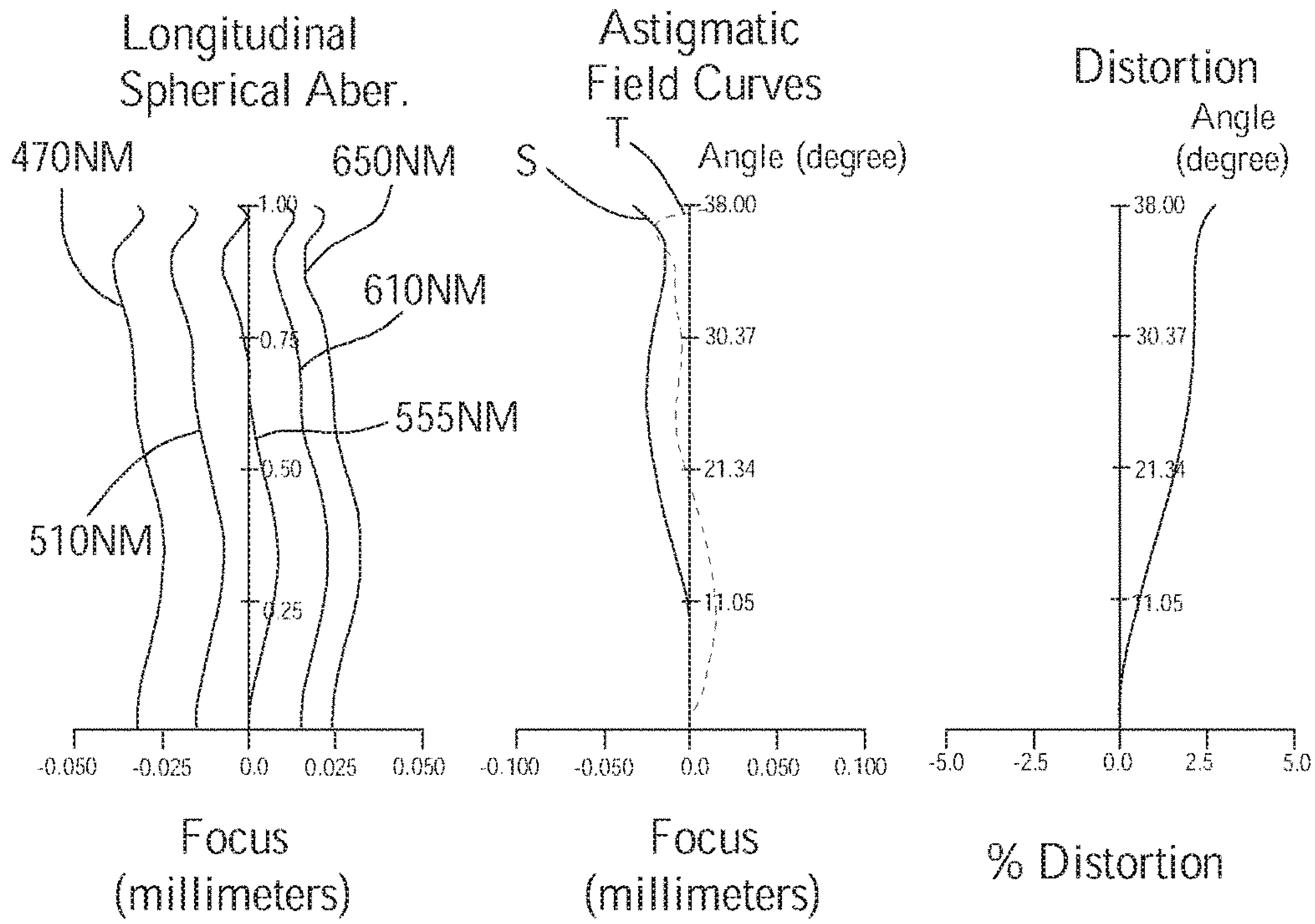

Longitudinal Spherical Aber.
470NM
650NM
610NM
555NM
510NM
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
Focus (millimeters)
Astigmatic Field Curves
S
T
Angle (degree)
38.00
30.37
21.34
11.05
-0.100 -0.050 0.0 0.050 0.100
Focus (millimeters)
Distortion
Angle (degree)
38.00
30.37
21.34
11.05
-5.0 -2.5 0.0 2.5 5.0
% Distortion

FIG. 1 B

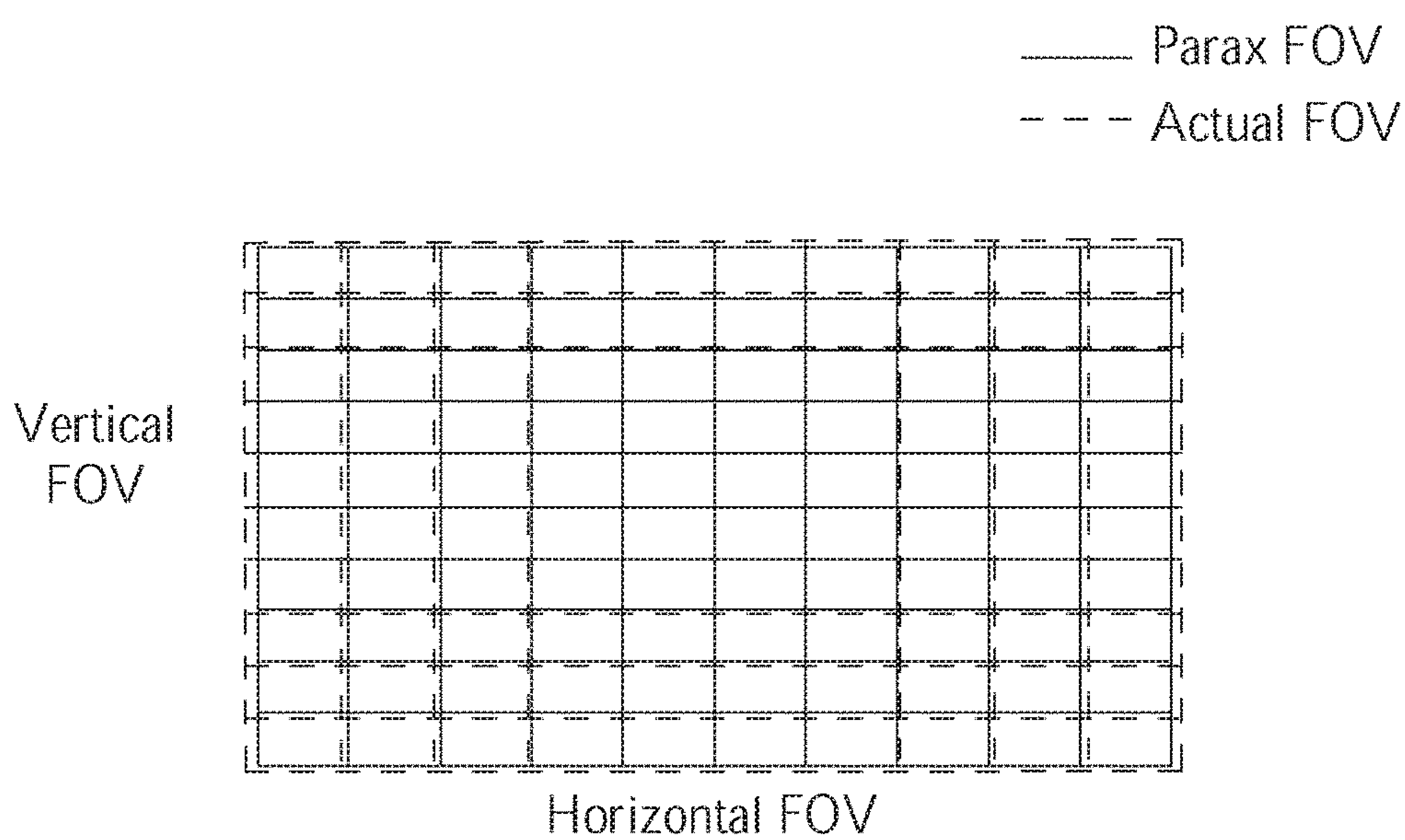
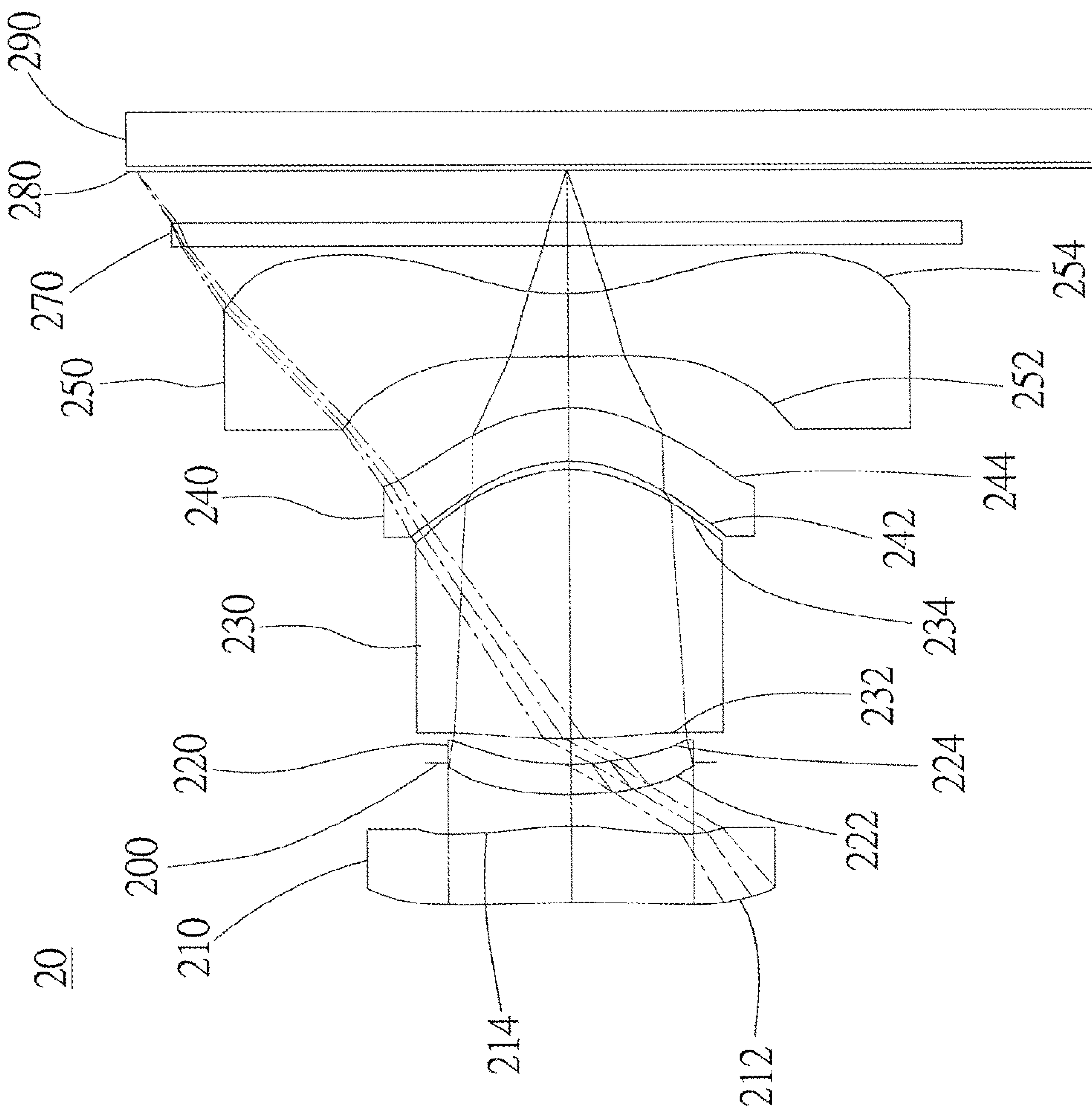

Parax FOV
Actual FOV
Vertical FOV
Horizontal FOV

FIG. 1 C



20
200
210
212
214
220
222
224
230
232
234
240
242
244
250
252
254
270
280
290

FIG. 2 A

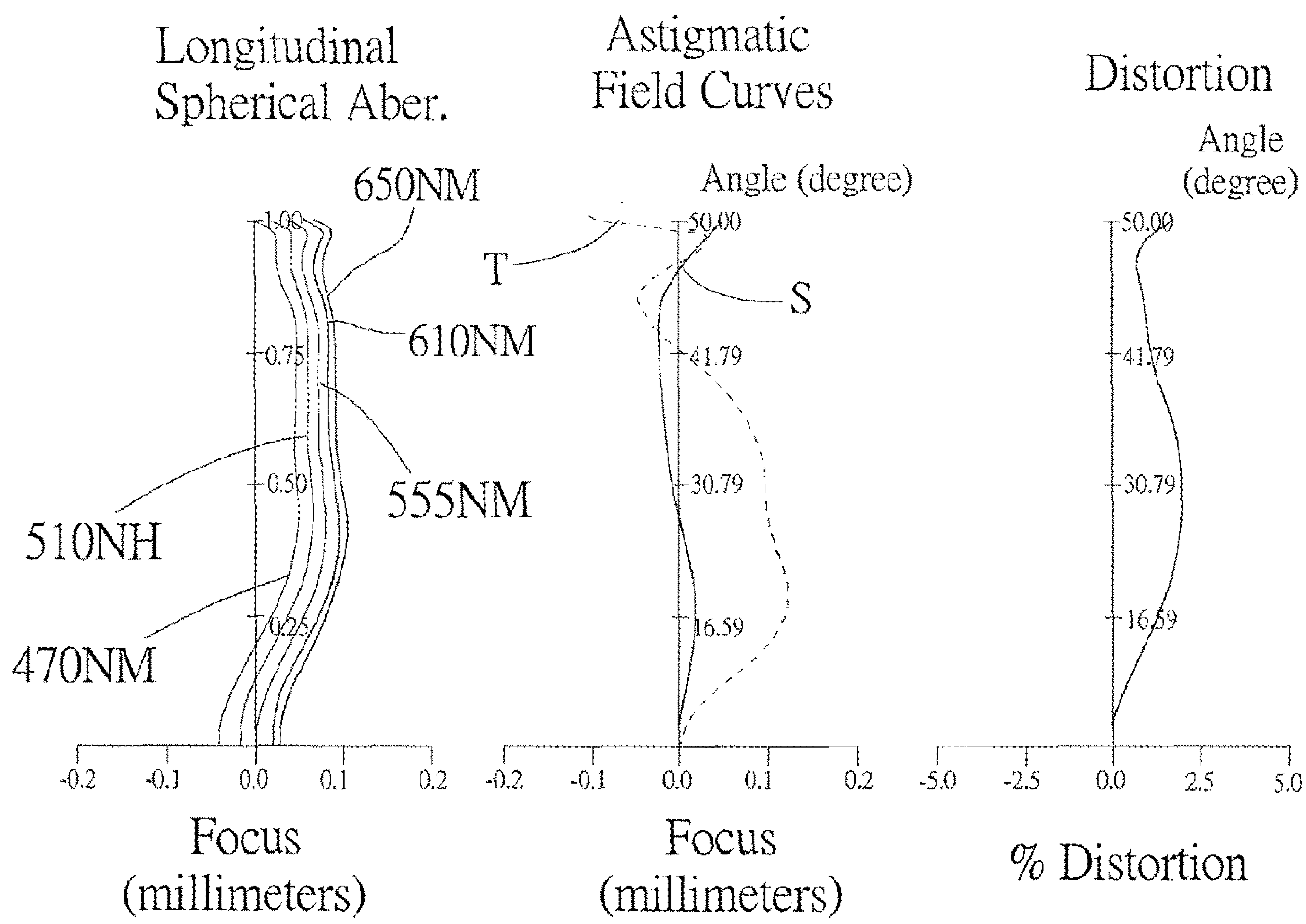

Longitudinal
Spherical Aber.
650NM
610NM
555NM
510NH
470NM
1.00
0.75
0.50
0.25
-0.2
-0.1
0.0
0.1
0.2
Focus
(millimeters)
Astigmatic
Field Curves
Angle (degree)
T
S
50.00
41.79
30.79
16.59
-0.2
-0.1
0.0
0.1
0.2
Focus
(millimeters)
Distortion
Angle
(degree)
50.00
41.79
30.79
16.59
-5.0
-2.5
0.0
2.5
5.0
% Distortion

FIG. 2 B

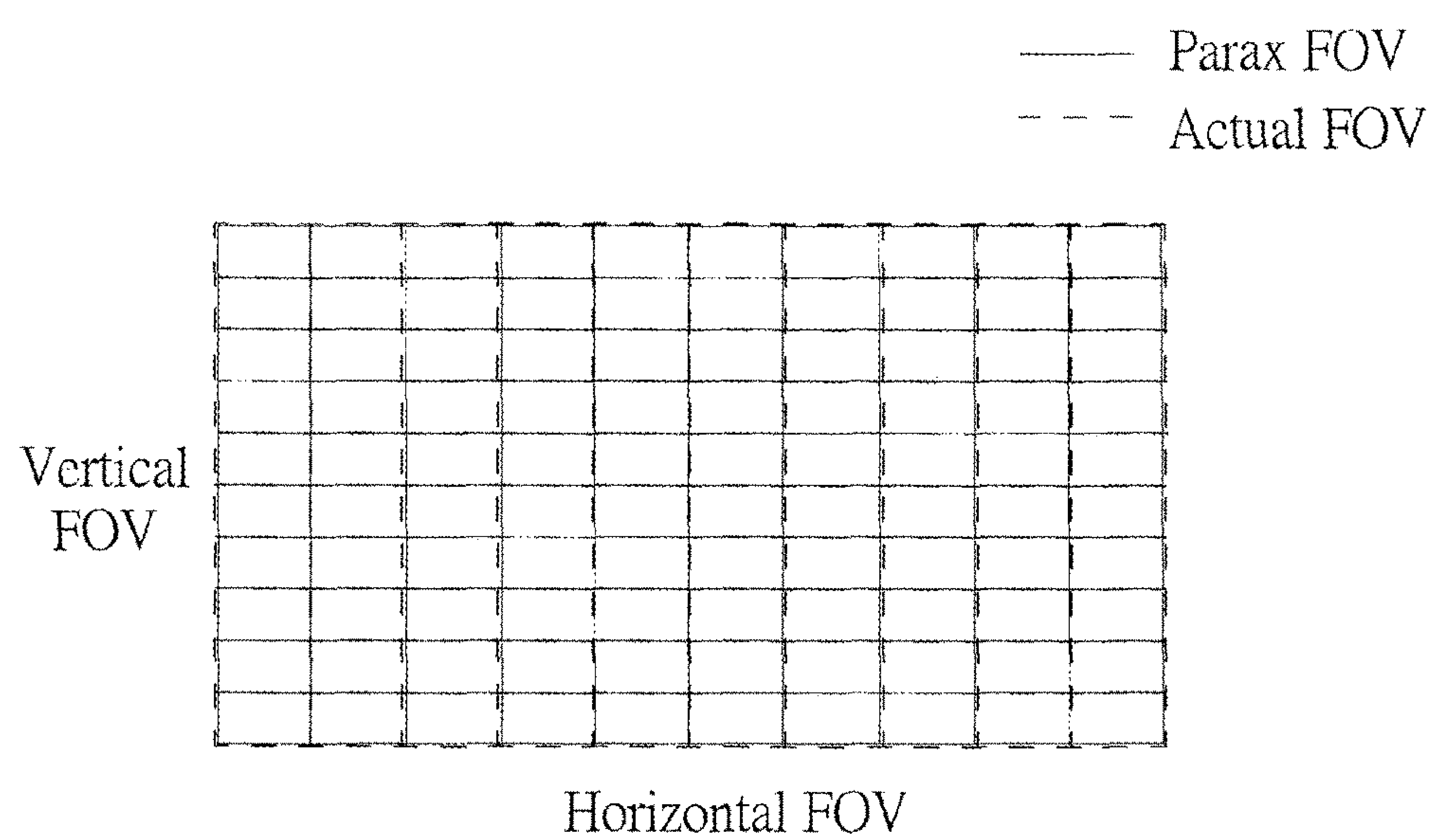

Parax FOV
Actual FOV
Vertical
FOV
Horizontal FOV

FIG. 2 C

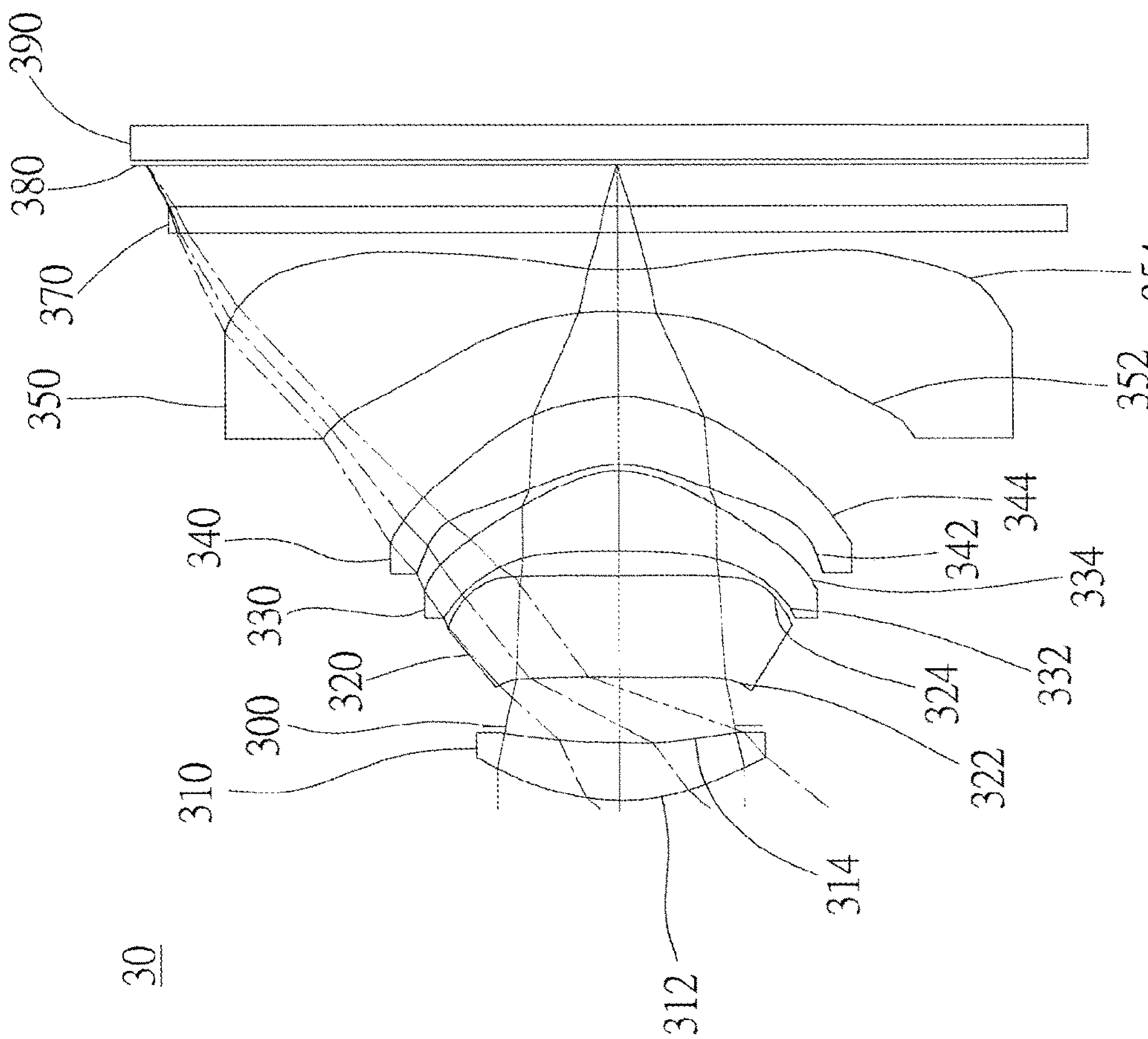
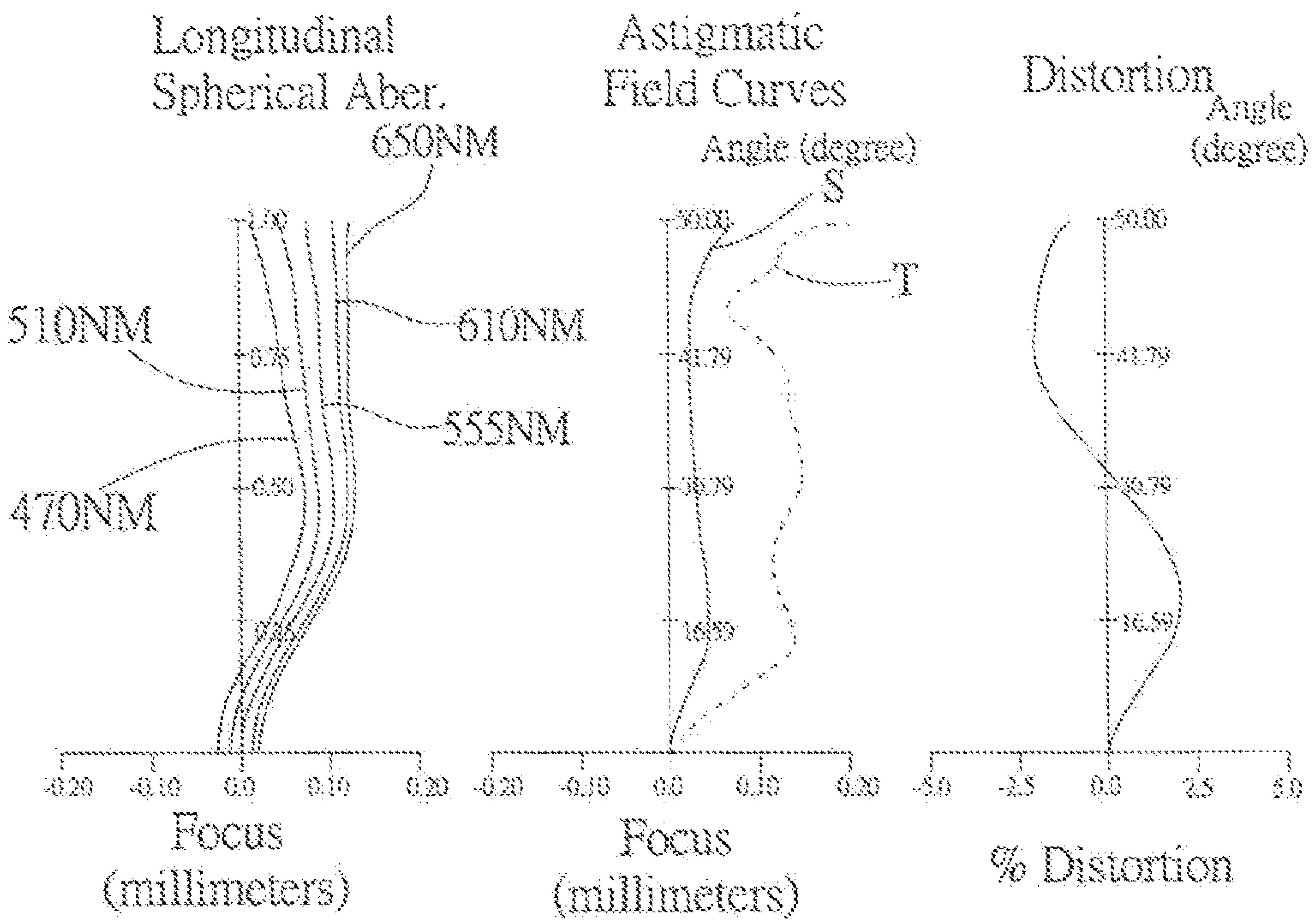
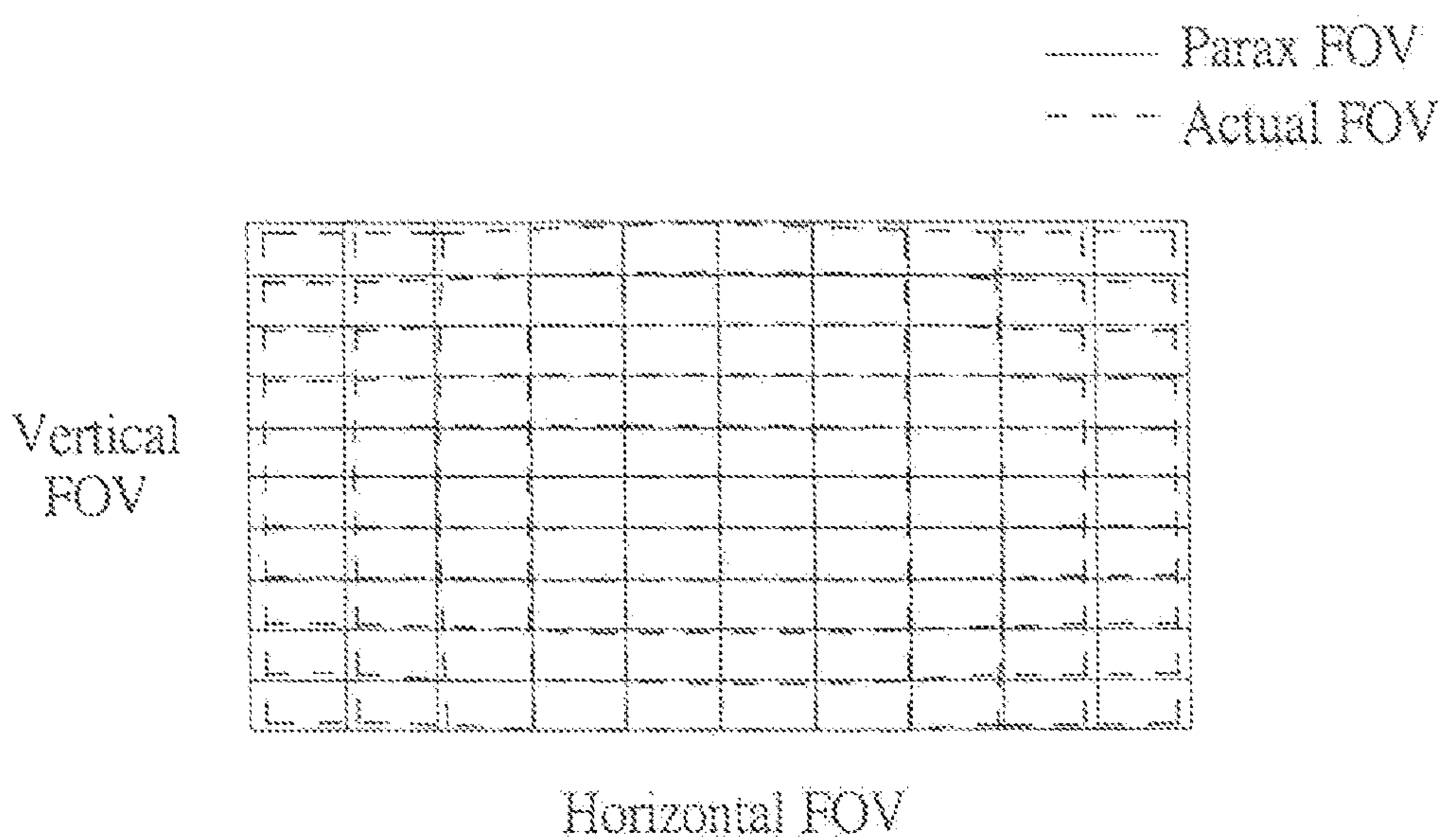

30
390
380
370
350
354
352
340
344
342
330
334
320
332
324
300
322
310
314
312

FIG. 3 A



Longitudinal Spherical Aber.
650NM
510NM
610NM
555NM
470NM
Focus (millimeters)
Astigmatic Field Curves
Angle (degree)
S
T
Focus (millimeters)
Distortion
Angle (degree)
% Distortion

FIG. 3 B



Parax FOV
Actual FOV
Vertical FOV
Horizontal FOV

FIG. 3 C

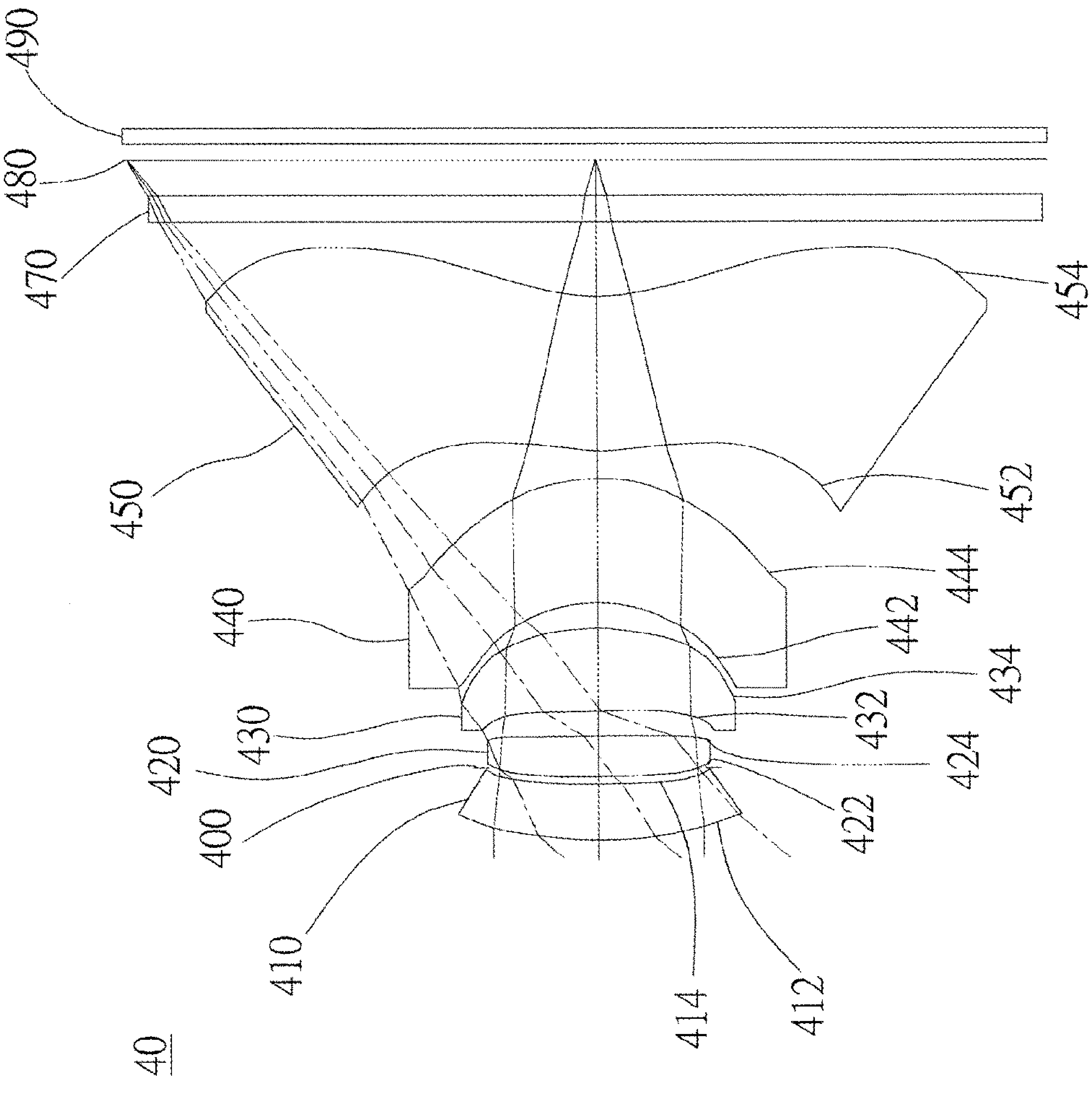

490
480
470
450
454
452
440
444
442
434
430
432
420
424
400
422
410
414
412
40

FIG. 4 A

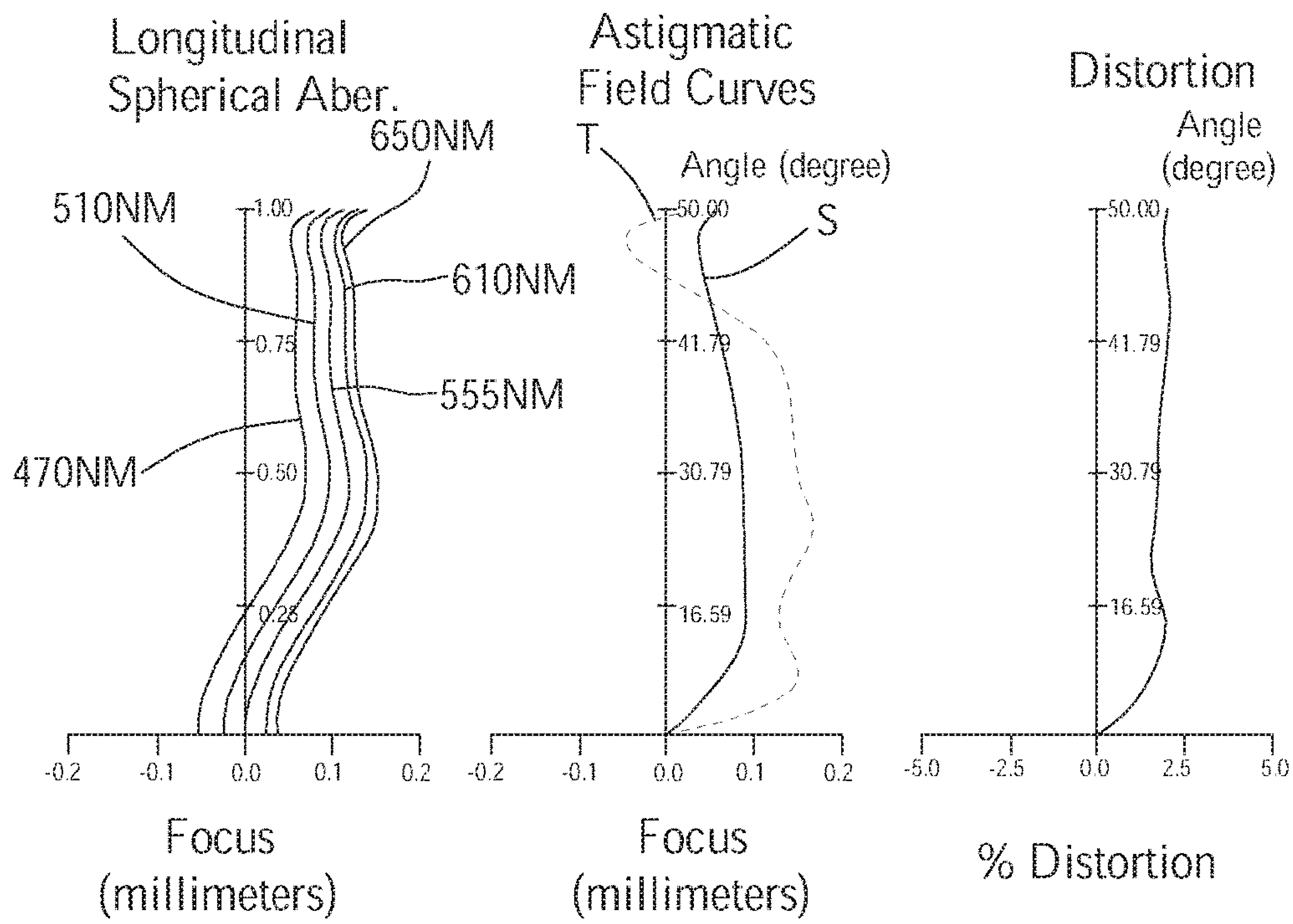

Longitudinal
Spherical Aber.
650NM
510NM
610NM
555NM
470NM
1.00
0.75
0.50
0.25
-0.2
-0.1
0.0
0.1
0.2
Focus
(millimeters)
Astigmatic
Field Curves
T
Angle (degree)
S
50.00
41.79
30.79
16.59
-0.2
-0.1
0.0
0.1
0.2
Focus
(millimeters)
Distortion
Angle
(degree)
50.00
41.79
30.79
16.59
-5.0
-2.5
0.0
2.5
5.0
% Distortion

FIG. 4 B

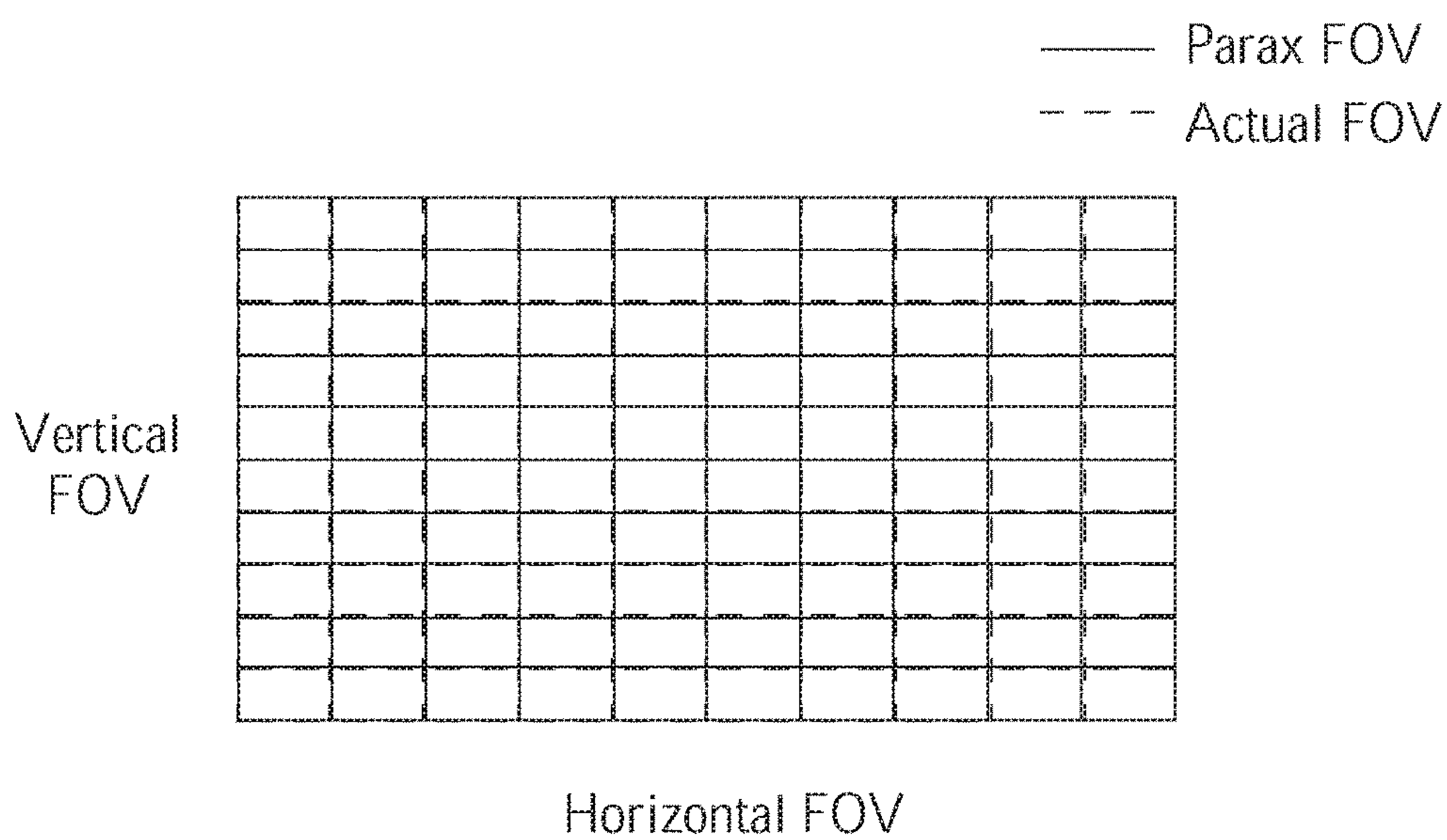

Parax FOV
Actual FOV
Vertical
FOV
Horizontal FOV

FIG. 4 C

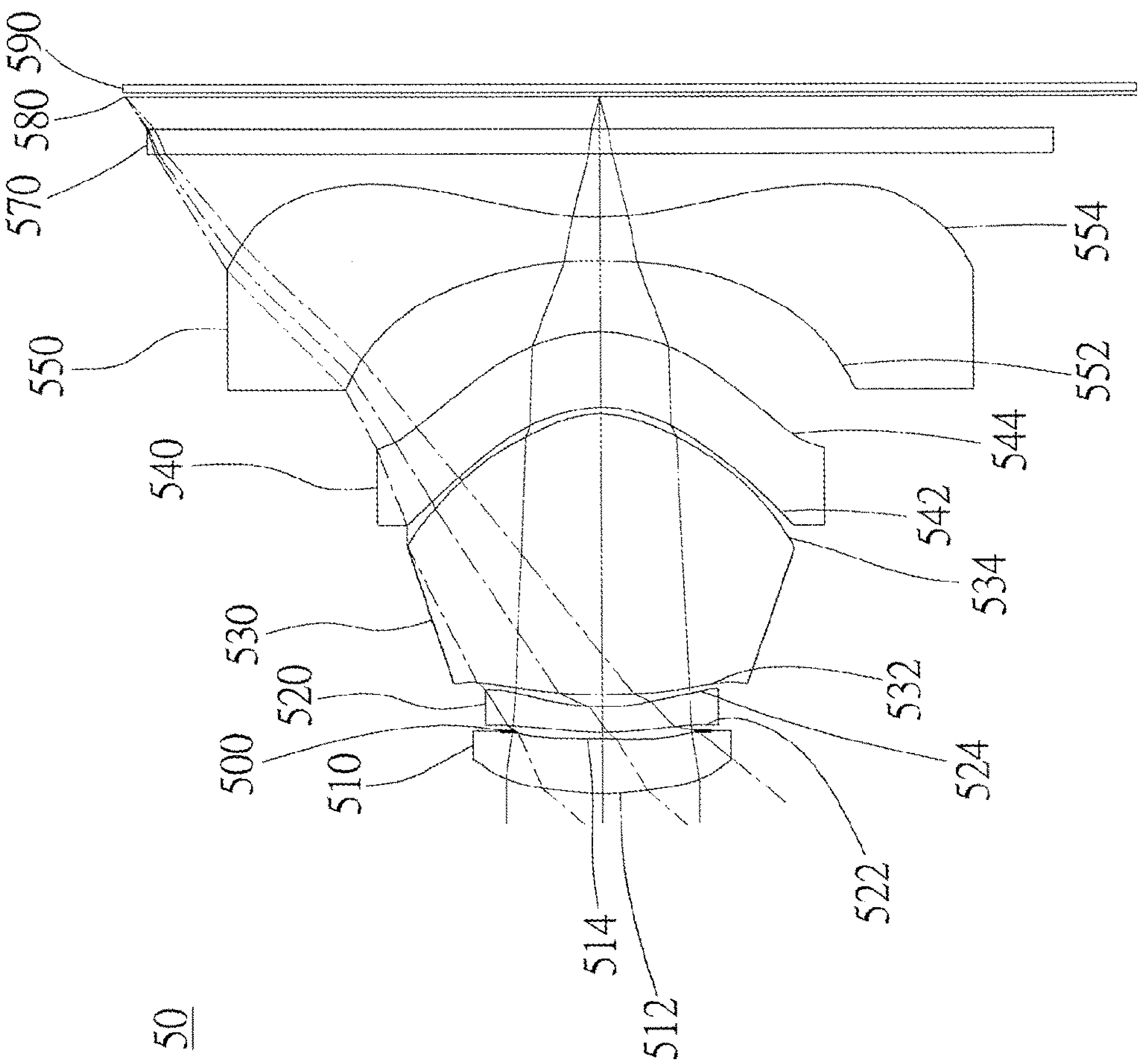

590
580
570
550
540
530
520
500
510
514
512
522
524
532
534
542
544
552
554
50

FIG. 5 A

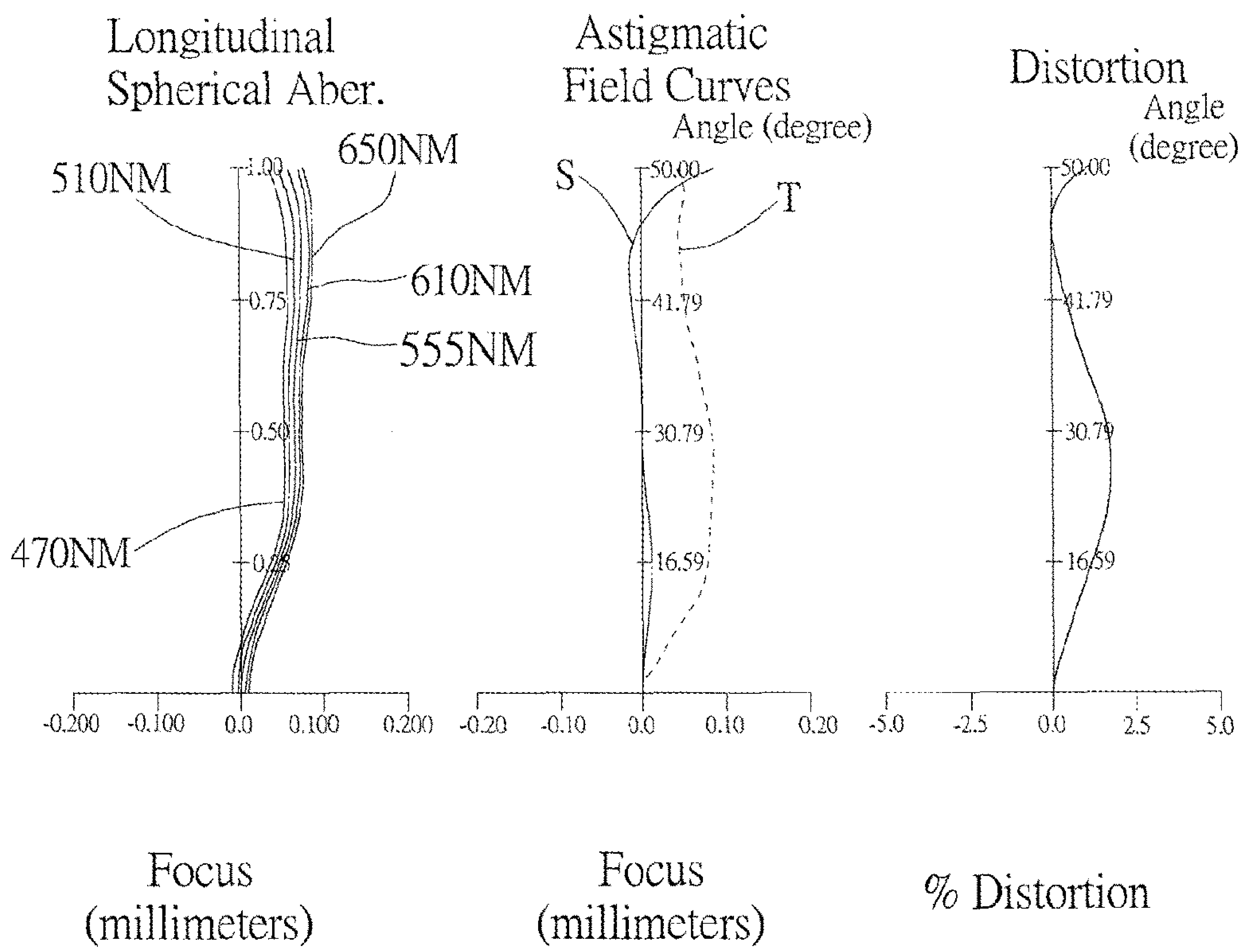

Longitudinal
Spherical Aber.
650NM
510NM
610NM
555NM
470NM
1.00
0.75
0.50
0.25
-0.200 -0.100 0.0 0.100 0.200
Focus
(millimeters)
Astigmatic
Field Curves
Angle (degree)
S
T
50.00
41.79
30.79
16.59
-0.20 -0.10 0.0 0.10 0.20
Focus
(millimeters)
Distortion
Angle
(degree)
50.00
41.79
30.79
16.59
-5.0 -2.5 0.0 2.5 5.0
% Distortion

FIG. 5 B

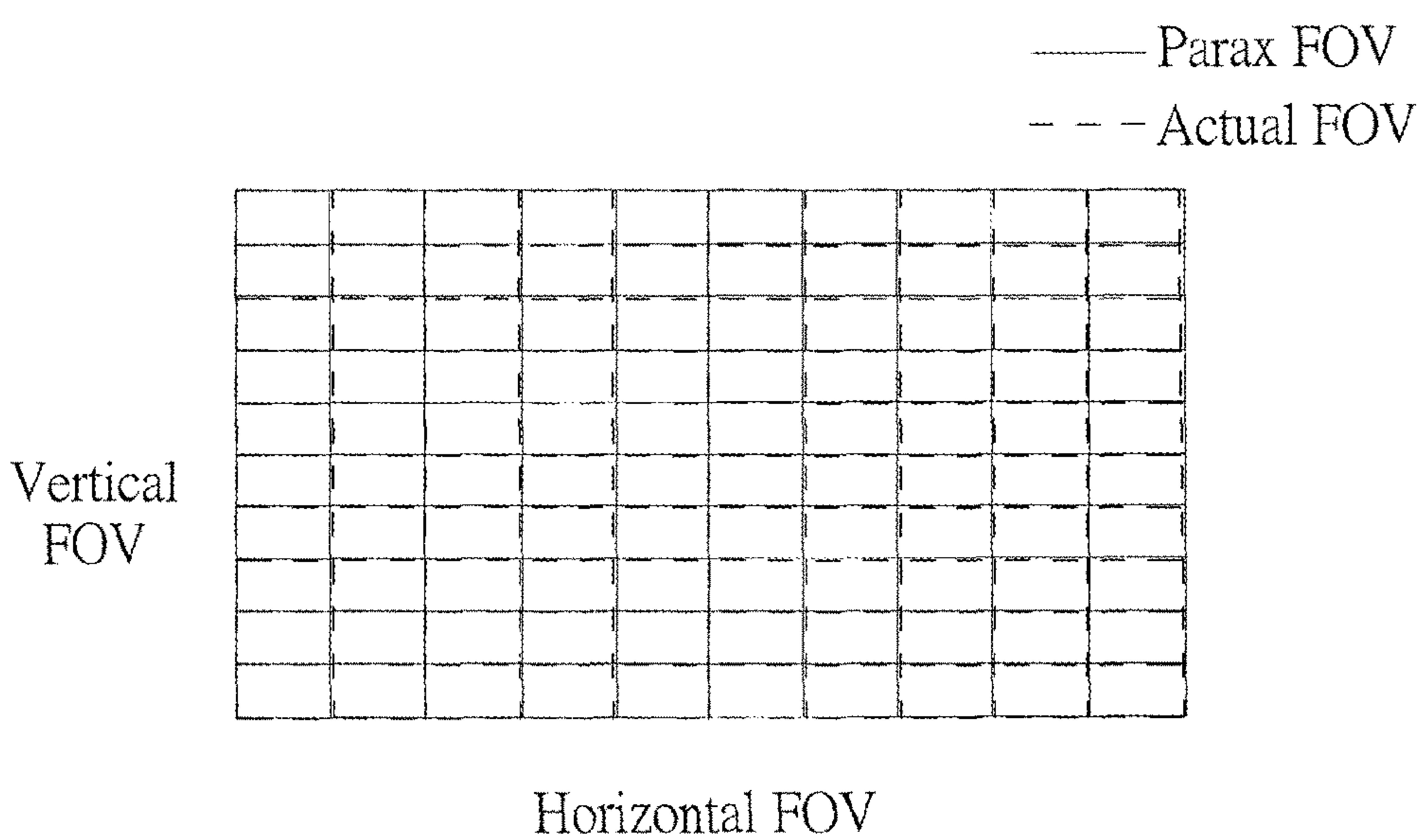

Parax FOV
Actual FOV
Vertical
FOV
Horizontal FOV

FIG. 5 C

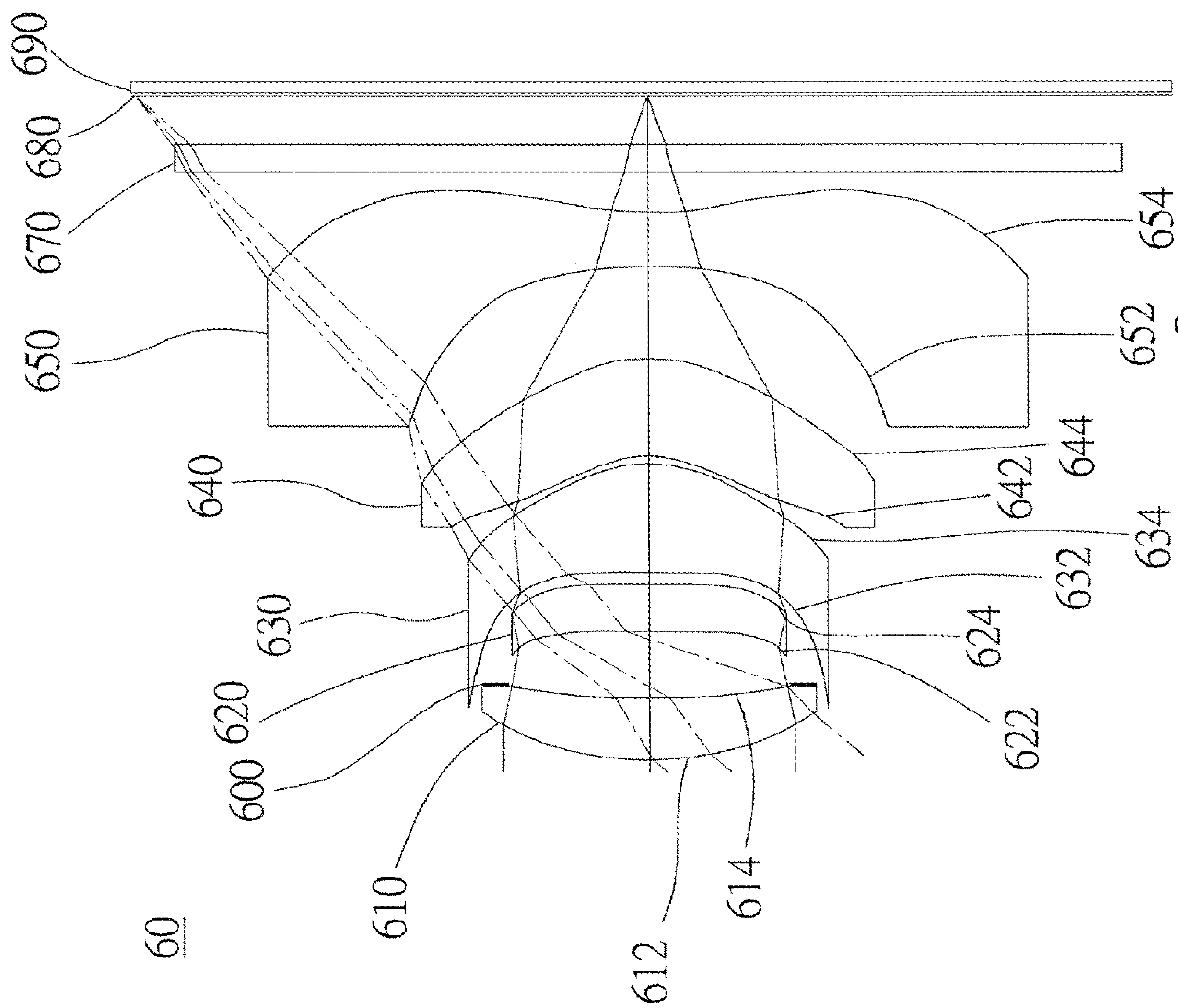

60
600
610
612
614
620
622
624
630
632
634
640
642
644
650
652
654
670
680
690

FIG. 6 A

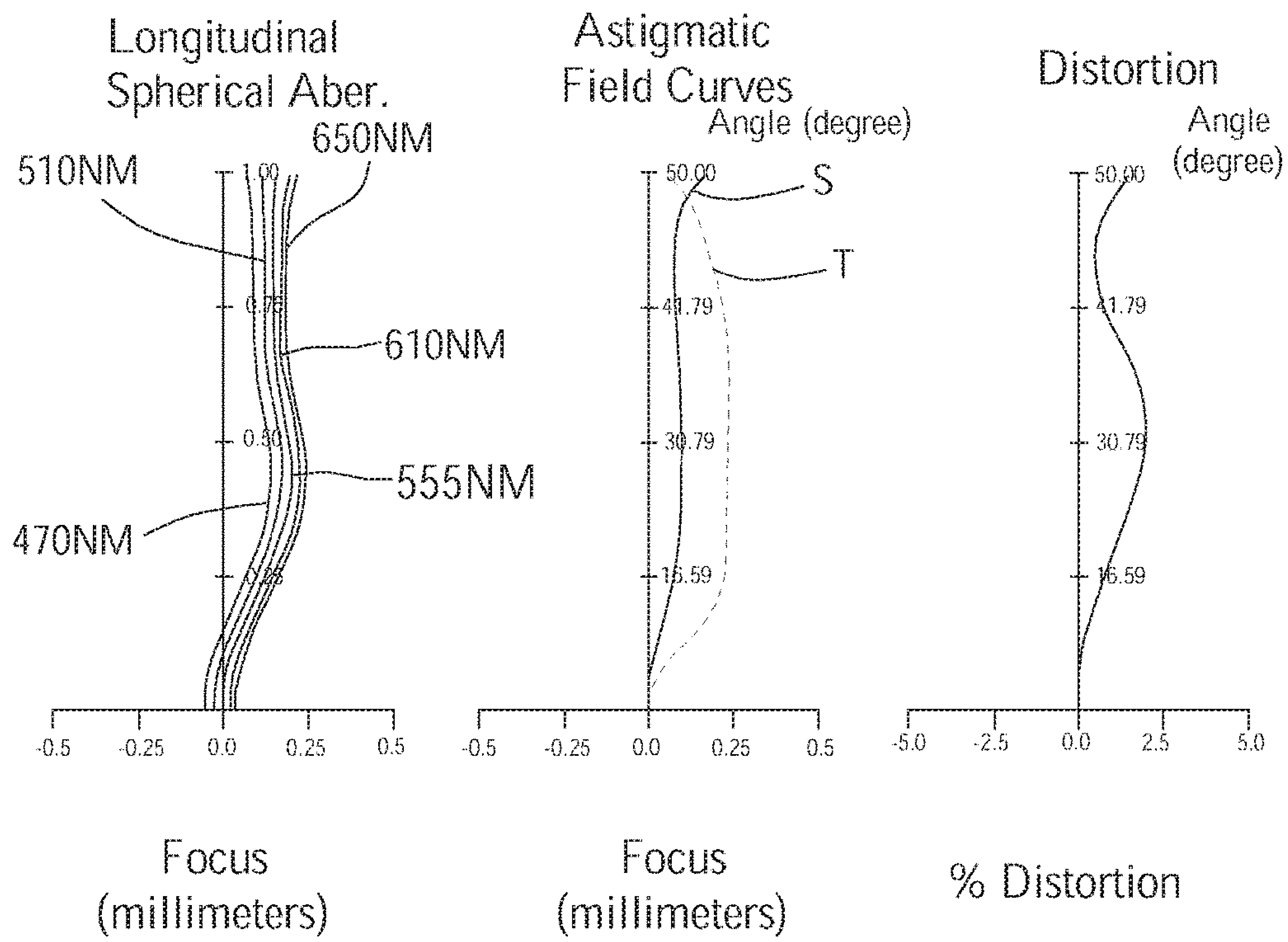

Longitudinal
Spherical Aber.
650NM
510NM
610NM
555NM
470NM
Focus
(millimeters)
Astigmatic
Field Curves
Angle (degree)
S
T
Focus
(millimeters)
Distortion
Angle
(degree)
% Distortion

FIG. 6 B

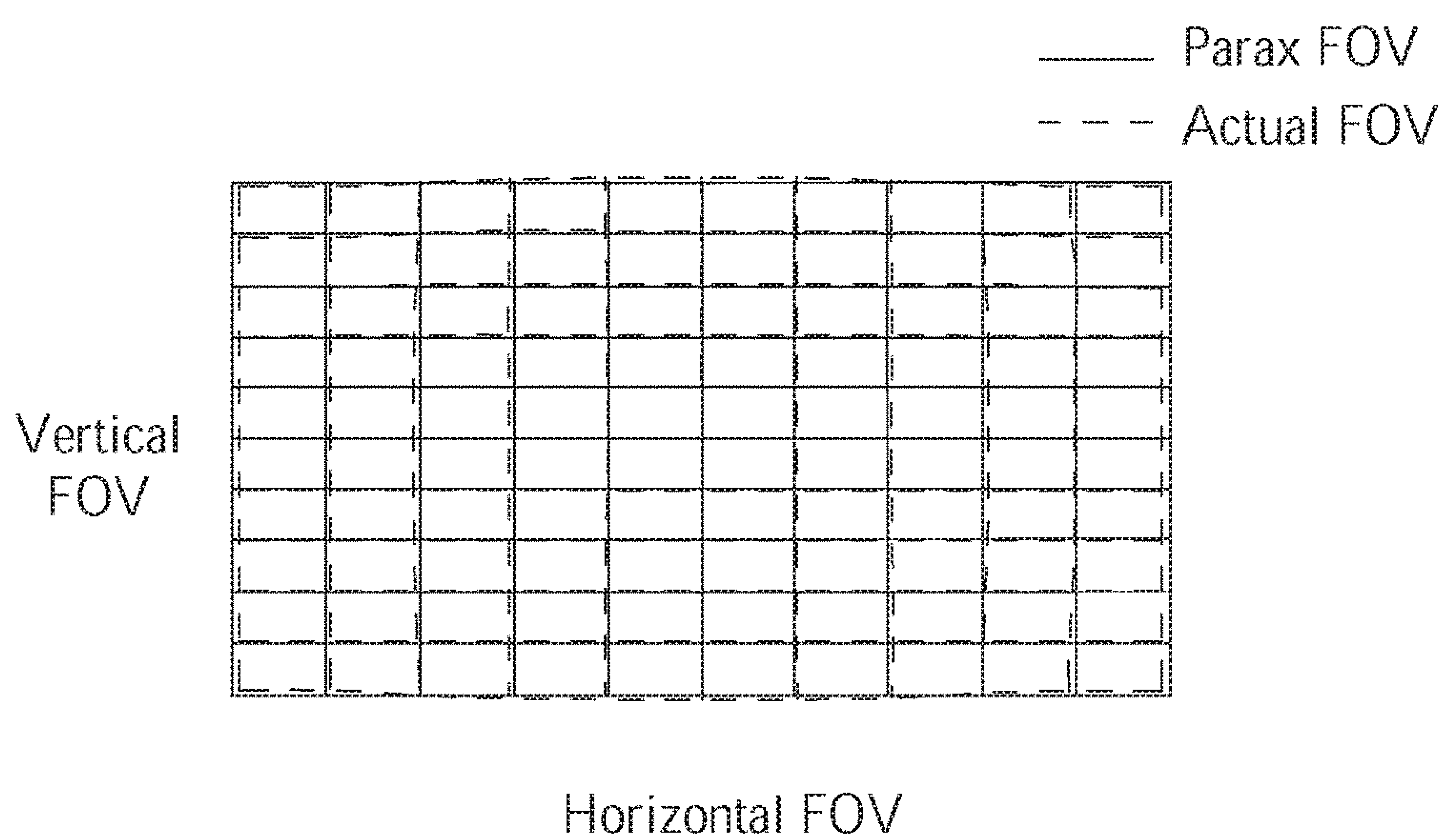

Parax FOV
Actual FOV
Vertical
FOV
Horizontal FOV

FIG. 6 C

OPTICAL IMAGE CAPTURING SYSTEM

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates generally to an optical system, and more particularly to a compact optical image capturing system for an electronic device.

2. Description of Related Art

In recent years, with the rise of portable electronic devices having camera functionalities, the demand for an optical image capturing system is raised gradually. The image sensing device of ordinary photographing camera is commonly selected from charge coupled device (CCD) or complementary metal-oxide semiconductor sensor (CMOS Sensor). In addition, as advanced semiconductor manufacturing technology enables the minimization of pixel size of the image sensing device, the development of the optical image capturing system towards the field of high pixels. Therefore, the requirement for high imaging quality is rapidly raised.

The conventional optical system of the portable electronic device usually has a three or four-piece lens. However, the optical system is asked to take pictures in a dark environment, in other words, the optical system is asked to have a large aperture. An optical system with large aperture usually has several problems, such as large aberration, poor image quality at periphery of the image, and hard to manufacture. In addition, an optical system of wide-angle usually has large distortion. Therefore, the conventional optical system provides high optical performance as required.

It is an important issue to increase the quantity of light entering the lens and the angle of field of the lens. In addition, the modern lens is also asked to have several characters, including high pixels, high image quality, small in size, and high optical performance.

SUMMARY OF THE INVENTION

The aspect of embodiment of the present disclosure directs to an optical image capturing system and an optical image capturing lens which use combination of refractive powers, convex and concave surfaces of five-piece optical lenses (the convex or concave surface in the disclosure denotes the geometrical shape of an image-side surface or an object-side surface of each lens on an optical axis) to increase the quantity of incoming light of the optical image capturing system, and to improve imaging quality for image formation, so as to be applied to minimized electronic products.

The term and its definition to the lens parameter in the embodiment of the present are shown as below for further reference.

The lens parameter related to a length or a height in the lens element:

A height for image formation of the optical image capturing system is denoted by HOI. A height of the optical image capturing system is denoted by HOS. A distance from the object-side surface of the first lens element to the image-side surface of the fifth lens element is denoted by InTL. A distance from the image-side surface of the fifth lens to the image plane is denoted by InB. InTL+InB=HOS. A distance from the first lens element to the second lens element is denoted by IN12 (instance). A central thickness of the first lens element of the optical image capturing system on the optical axis is denoted by TP1 (instance).

The lens parameter related to a material in the lens:

An Abbe number of the first lens element in the optical image capturing system is denoted by NA1 (instance). A refractive index of the first lens element is denoted by Nd1 (instance).

The lens parameter related to a view angle in the lens:

A view angle is denoted by AF. Half of the view angle is denoted by HAF. A major light angle is denoted by MRA.

The lens parameter related to exit/entrance pupil in the lens

An entrance pupil diameter of the optical image capturing system is denoted by HEP.

The lens parameter related to a depth of the lens shape

A distance in parallel with an optical axis from a maximum effective semi diameter position to an axial point on the object-side surface of the fifth lens is denoted by InRS51 (instance). A distance in parallel with an optical axis from a maximum effective semi diameter position to an axial point on the image-side surface of the fifth lens is denoted by InRS52 (instance).

The lens parameter related to the lens shape:

A critical point C is a tangent point on a surface of a specific lens, and the tangent point is tangent to a plane perpendicular to the optical axis and the tangent point cannot be a crossover point on the optical axis. To follow the past, a distance perpendicular to the optical axis between a critical point C41 on the object-side surface of the fourth lens and the optical axis is HVT41 (instance). A distance perpendicular to the optical axis between a critical point C42 on the image-side surface of the fourth lens and the optical axis is HVT42 (instance). A distance perpendicular to the optical axis between a critical point C51 on the object-side surface of the fifth lens and the optical axis is HVT51 (instance). A distance perpendicular to the optical axis between a critical point C52 on the image-side surface of the fifth lens and the optical axis is HVT52 (instance). The object-side surface of the fifth lens has one inflection point IF511 which is nearest to the optical axis, and the sinkage value of the inflection point IF511 is denoted by SGI511. A distance perpendicular to the optical axis between the inflection point IF511 and the optical axis is HIF511 (instance). The image-side surface of the fifth lens has one inflection point IF521 which is nearest to the optical axis, and the sinkage value of the inflection point IF521 is denoted by SGI521 (instance). A distance perpendicular to the optical axis between the inflection point IF521 and the optical axis is HIF521 (instance). The object-side surface of the fifth lens has one inflection point IF512 which is the second nearest to the optical axis, and the sinkage value of the inflection point IF512 is denoted by SGI512 (instance). A distance perpendicular to the optical axis between the inflection point IF512 and the optical axis is HIF512 (instance). The image-side surface of the fifth lens has one inflection point IF522 which is the second nearest to the optical axis, and the sinkage value of the inflection point IF522 is denoted by SGI522 (instance). A distance perpendicular to the optical axis between the inflection point IF522 and the optical axis is HIF522 (instance).

The lens element parameter related to an aberration:

Optical distortion for image formation in the optical image capturing system is denoted by ODT. TV distortion for image formation in the optical image capturing system is denoted by TDT. Further, the range of the aberration offset for the view of image formation may be limited to 50%-100% field. An offset of the spherical aberration is denoted by DFS. An offset of the coma aberration is denoted by DFC.

The present invention provides an optical image capturing system, in which the fifth lens is provided with an inflection point at the object-side surface or at the image-side surface to adjust the incident angle of each view field and modify the ODT and the TDT. In addition, the surfaces of the fifth lens are capable of modifying the optical path to improve the imaging quality.

The optical image capturing system of the present invention includes a first lens, a second lens, a third lens, a fourth lens, and a fifth lens in order along an optical axis from an object side to an image side. The first lens has positive refractive power, and the fifth lens has refractive power. Both the object-side surface and the image-side surface of the fifth lens are aspheric surfaces. The optical image capturing system satisfies:

$$1.2 \leq f/HEP \leq 2.8 \text{ and } 0.5 \leq HOS/f \leq 3.0;$$

where f is a focal length of the optical image capturing system; HEP is an entrance pupil diameter of the optical image capturing system; and HOS is a distance in parallel with the optical axis between an object-side surface, which face the object side, of the first lens and the image plane.

The present invention further provides an optical image capturing system, including a first lens, a second lens, a third lens, a fourth lens, and a fifth lens in order along an optical axis from an object side to an image side. The first lens has positive refractive power, and both the object-side surface and the image-side surface thereof are aspheric surfaces. The second lens has negative refractive power, and the third and the fourth lenses have refractive power. The fifth lens has refractive power, and both an object-side surface and an image-side surface thereof are aspheric surfaces. The optical image capturing system satisfies:

$$1.2 \leq f/HEP \leq 2.8;\ 0.5 \leq HOS/f \leq 3.0;\ 0.4 \leq |\tan(HAF)| \leq 3.0;\ |TDT| < 60\%;\text{ and } |ODT| \leq 50\%;$$

where f is a focal length of the optical image capturing system; HEP is an entrance pupil diameter of the optical image capturing system; HOS is a distance in parallel with the optical axis between an object-side surface, which face the object side, of the first lens and the image plane; HAF is a half of the view angle of the optical image capturing system; TDT is a TV distortion; and ODT is an optical distortion.

The present invention further provides an optical image capturing system, including a first lens, a second lens, a third lens, a fourth lens, and a fifth lens in order along an optical axis from an object side to an image side. At least two of these five lenses have at least an inflection point on a side thereof respectively. The first lens has positive refractive power, and both an object-side surface and an image-side surface thereof are aspheric surfaces. The second and the third lens have refractive power, and the fourth lens has negative refractive power. The fifth lens has negative refractive power, wherein an image-side surface thereof has at least an inflection point, and both an object-side surface and the image side surface thereof are aspheric surfaces. The optical image capturing system satisfies:

$$1.2 \leq f/HEP \leq 2.8;\ 0.5 \leq HOS/f \leq 3.0;\ 0.4 \leq |\tan(HAF)| \leq 3.0;\ |TDT| < 60\%;\text{ and } |ODT| \leq 50\%;$$

where f is a focal length of the optical image capturing system; HEP is an entrance pupil diameter of the optical image capturing system; HOS is a distance in parallel with the optical axis between an object-side surface, which face the object side, of the first lens and the image plane; HAF is a half of the view angle of the optical image capturing system; TDT is a TV distortion; and ODT is an optical distortion.

In an embodiment, the optical image capturing system further includes an image sensor with a size less than 1/1.2" in diagonal, and a pixel less than 1.4 μm. A preferable size is 1/2.3", and a preferable pixel size of the image sensor is less than 1.12 μm, and more preferable pixel size is less than 0.9 μm. A 16:9 image sensor is available for the optical image capturing system of the present invention.

In an embodiment, the optical image capturing system of the present invention is available to high-quality (4K2K, so called UHD and QHD) recording, and provides high quality of image.

In an embodiment, a height of the optical image capturing system (HOS) can be reduced while $|f1| > f5$.

In an embodiment, when the lenses satisfy $|f2|+|f3|+|f4|>|f1|+|f5|$, at least one of the lenses from the second lens to the fourth lens could have weak positive refractive power or weak negative refractive power. The weak refractive power indicates that an absolute value of the focal length is greater than 10. When at least one of the lenses from the second lens to the fourth lens could have weak positive refractive power, it may share the positive refractive power of the first lens, and on the contrary, when at least one of the lenses from the second lens to the fourth lens could have weak negative refractive power, it may finely modify the aberration of the system.

In an embodiment, the fifth lens has negative refractive power, and an image-side surface thereof can be concave, it may reduce back focal length and size. Besides, the fifth lens has at least an inflection point on at least a surface thereof, which may reduce an incident angle of the light of an off-axis field of view and modify the aberration of the off-axis field of view.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The present invention will be best understood by referring to the following detailed description of some illustrative embodiments in conjunction with the accompanying drawings, in which

FIG. **1**A is a schematic diagram of a first preferred embodiment of the present invention;

FIG. **1**B shows curve diagrams of longitudinal spherical aberration, astigmatic field, and optical distortion of the optical image capturing system in the order from left to right of the first embodiment of the present application;

FIG. **1**C shows a curve diagram of TV distortion of the optical image capturing system of the first embodiment of the present application;

FIG. **2**A is a schematic diagram of a second preferred embodiment of the present invention;

FIG. **2**B shows curve diagrams of longitudinal spherical aberration, astigmatic field, and optical distortion of the optical image capturing system in the order from left to right of the second embodiment of the present application;

FIG. **2**C shows a curve diagram of TV distortion of the optical image capturing system of the second embodiment of the present application;

FIG. **3**A is a schematic diagram of a third preferred embodiment of the present invention;

FIG. **3**B shows curve diagrams of longitudinal spherical aberration, astigmatic field, and optical distortion of the optical image capturing system in the order from left to right of the third embodiment of the present application;

FIG. **3**C shows a curve diagram of TV distortion of the optical image capturing system of the third embodiment of the present application;

FIG. **4**A is a schematic diagram of a fourth preferred embodiment of the present invention;

FIG. 4B shows curve diagrams of longitudinal spherical aberration, astigmatic field, and optical distortion of the optical image capturing system in the order from left to right of the fourth embodiment of the present application;

FIG. 4C shows a curve diagram of TV distortion of the optical image capturing system of the fourth embodiment of the present application;

FIG. 5A is a schematic diagram of a fifth preferred embodiment of the present invention;

FIG. 5B shows curve diagrams of longitudinal spherical aberration, astigmatic field, and optical distortion of the optical image capturing system in the order from left to right of the fifth embodiment of the present application;

FIG. 5C shows a curve diagram of TV distortion of the optical image capturing system of the fifth embodiment of the present application;

FIG. 6A is a schematic diagram of a sixth preferred embodiment of the present invention;

FIG. 6B shows curve diagrams of longitudinal spherical aberration, astigmatic field, and optical distortion of the optical image capturing system in the order from left to right of the sixth embodiment of the present application; and

FIG. 6C shows a curve diagram of TV distortion of the optical image capturing system of the sixth embodiment of the present application.

DETAILED DESCRIPTION OF THE INVENTION

An optical image capturing system of the present invention includes a first lens, a second lens, a third lens, a fourth lens, and a fifth lens from an object side to an image side. The optical image capturing system further is provided with an image sensor at an image plane.

The optical image capturing system works in three wavelengths, including 486.1 nm, 587.5 nm, and 656.2 nm, wherein 587.5 mm is the main reference wavelength, and 555 nm is adopted as the main reference wavelength for extracting features.

The optical image capturing system of the present invention satisfies $0.5 \leq \Sigma PPR/|\Sigma NPR| \leq 2.5$, and a preferable range is $1 \leq \Sigma PPR/|\Sigma NPR| \leq 2.0$, where PPR is a ratio of the focal length f of the optical image capturing system to a focal length fp of each of lenses with positive refractive power; NPR is a ratio of the focal length f of the optical image capturing system to a focal length fn of each of lenses with negative refractive power; ΣPPR is a sum of the PPRs of each positive lens, and ΣNPR is a sum of the NPRs of each negative lens. It is helpful to control of an entire refractive power and an entire length of the optical image capturing system.

HOS is a height of the optical image capturing system, and when the ratio of HOS/f approaches to 1, it is helpful for decrease of size and increase of imaging quality.

In an embodiment, the optical image capturing system of the present invention satisfies $0 < \Sigma PP \leq 200$ and $f1/\Sigma PP \leq 0.85$, and a preferable range is $0 < \Sigma PP \leq 150$ and $0.01 \leq f1/\Sigma PP \leq 0.6$, where ΣPP is a sum of a focal length fp of each lens with positive refractive power, and ΣNP is a sum of a focal length fn of each lens with negative refractive power. It is helpful to control of focusing capacity of the system and redistribution of the positive refractive powers of the system to avoid the significant aberration in early time. The optical image capturing system further satisfies $\Sigma NP < -0.1$ and $f5/\Sigma NP \leq 0.85$, and preferably satisfies $\Sigma NP < 0$ and $0.01 \leq f5/\Sigma NP \leq 0.5$, which is helpful to control of an entire refractive power and an entire length of the optical image capturing system.

The first lens has positive refractive power, and an object-side surface, which faces the object side, thereof can be convex. It may modify the positive refractive power of the first lens as well as shorten the entire length of the system.

The second lens can have negative refractive power, which may correct the aberration of the first lens.

The third lens can have positive refractive power, which may share the positive refractive power of the first lens.

The fourth lens can have negative refractive power, and an image-side surface thereof, which faces the image side, can be convex. The fourth lens may share the positive refractive power of the first lens to reduce an increase of the aberration and reduce a sensitivity of the system.

The fifth lens has negative refractive power, and an image-side surface thereof, which faces the image side, can be concave. It may shorten a rear focal length to reduce the size of the system. In addition, the fifth lens is provided with at least an inflection point on at least a surface to reduce an incident angle of the light of an off-axis field of view and modify the aberration of the off-axis field of view. It is preferable that each surface, the object-side surface and the image-side surface, of the fifth lens has at least an inflection point.

The image sensor is provided on the image plane. The optical image capturing system of the present invention satisfies $HOS/HOI \leq 3$ and $0.5 \leq HOS/f \leq 3.0$, and a preferable range is $1 \leq HOS/HOI \leq 2.5$ and $1 \leq HOS/f \leq 2$, where HOI is height for image formation of the optical image capturing system, i.e., the maximum image height, and HOS is a height of the optical image capturing system, i.e., a distance on the optical axis between the object-side surface of the first lens and the image plane. It is helpful for reduction of size of the system for used in compact cameras.

The optical image capturing system of the present invention further is provided with an aperture to increase image quality.

In the optical image capturing system of the present invention, the aperture could be a front aperture or a middle aperture, wherein the front aperture is provided between the object and the first lens, and the middle is provided between the first lens and the image plane. The front aperture provides a long distance between an exit pupil of the system and the image plane, which allows more elements to be installed. The middle could enlarge a view angle of view of the system and increase the efficiency of the image sensor. The optical image capturing system satisfies $0.5 \leq InS/HOS \leq 1.1$, and a preferable range is $0.8 \leq InS/HOS \leq 1$, where InS is a distance between the aperture and the image plane. It is helpful for size reduction and wide angle.

The optical image capturing system of the present invention satisfies $0.45 \leq \Sigma TP/InTL \leq 0.95$, where InTL is a distance between the object-side surface of the first lens and the image-side surface of the fifth lens, and ΣTP is a sum of central thicknesses of the lenses on the optical axis. It is helpful for the contrast of image and yield of manufacture, and provides a suitable back focal length for installation of other elements.

The optical image capturing system of the present invention satisfies $0.1 \leq |R1/R2| \leq 5$, and a preferable range is $0.1 \leq |R1/R2| \leq 4$, where R1 is a radius of curvature of the object-side surface of the first lens, and R2 is a radius of curvature of the image-side surface of the first lens. It provides the first lens with a suitable positive refractive power to reduce the increase rate of the spherical aberration.

The optical image capturing system of the present invention satisfies $-200<(R9-R10)/(R9+R10)<30$, where R9 is a radius of curvature of the object-side surface of the fifth lens, and R10 is a radius of curvature of the image-side surface of the fifth lens. It may modify the astigmatic field curvature.

The optical image capturing system of the present invention satisfies $0<IN12/f\leq 0.25$, and a preferable range is $0.01\leq IN12/f\leq 0.20$, where IN12 is a distance on the optical axis between the first lens and the second lens. It may correct chromatic aberration and improve the performance.

The optical image capturing system of the present invention satisfies $1\leq(TP1+IN12)/TP2\leq 10$, where TP1 is a central thickness of the first lens on the optical axis, and TP2 is a central thickness of the second lens on the optical axis. It may control the sensitivity of manufacture of the system and improve the performance.

The optical image capturing system of the present invention satisfies $0.2\leq(TP5+IN45)/TP4\leq 3$, where TP4 is a central thickness of the fourth lens on the optical axis, TP5 is a central thickness of the fifth lens on the optical axis, and IN45 is a distance between the fourth lens and the fifth lens. It may control the sensitivity of manufacture of the system and improve the performance.

The optical image capturing system of the present invention satisfies $0.1\leq(TP2+TP3+TP4)/\Sigma TP\leq 0.9$, and a preferable range is $0.4\leq(TP2+TP3+TP4)/\Sigma TP\leq 0.8$, where TP2 is a central thickness of the second lens on the optical axis, TP3 is a central thickness of the third lens on the optical axis, TP4 is a central thickness of the fourth lens on the optical axis, TP5 is a central thickness of the fifth lens on the optical axis, and ΣTP is a sum of the central thicknesses of all the lenses on the optical axis. It may finely modify the aberration of the incident rays and reduce the height of the system.

The optical image capturing system of the present invention satisfies $-1.5\text{ mm}\leq InRS51\leq 1.5\text{ mm}$; $-1.5\text{ mm}\leq InRS52\leq 1.5\text{ mm}$; $0\text{ mm}\leq|InRS51|+|InRS52|\leq 3\text{ mm}$; $0.01\leq|InRS51|/TP5\leq 10$; and $0.01\leq|InRS52|/TP5\leq 10$, where InRS51 is a displacement in parallel with the optical axis from a point on the object-side surface of the fifth lens, through which the optical axis passes, to a point at the maximum effective semi diameter of the object-side surface of the fifth lens, wherein InRS51 is positive while the displacement is toward the image side, and InRS51 is negative while the displacement is toward the object side; InRS52 is a displacement in parallel with the optical axis from a point on the image-side surface of the fifth lens, through which the optical axis passes, to a point at the maximum effective semi diameter of the image-side surface of the fifth lens; and TP5 is a central thickness of the fifth lens on the optical axis. It may control the positions of the maximum effective semi diameter on both surfaces of the fifth lens, correct the aberration of the spherical field of view, and reduce the size.

The optical image capturing system of the present invention satisfies $0<SGI511/(SGI511+TP5)\leq 0.9$ and $0<SGI521/(SGI521+TP5)\leq 0.9$, and a preferable range is $0.01<SGI511/(SGI511+TP5)\leq 0.7$ and $0.01<SGI521/(SGI521+TP5)\leq 0.7$, where SGI511 is a displacement in parallel with the optical axis from a point on the object-side surface of the fifth lens, through which the optical axis passes, to an inflection point, which is the closest to the optical axis, on the object-side surface of the fifth lens; SGI521 is a displacement in parallel with the optical axis from a point on the image-side surface of the fifth lens, through which the optical axis passes, to an inflection point, which is the closest to the optical axis, on the image-side surface of the fifth lens, and TP5 is a thickness of the fifth lens on the optical axis.

The optical image capturing system of the present invention satisfies $0<SGI512/(SGI512+TP5)\leq 0.9$ and $0<SGI522/(SGI522+TP5)\leq 0.9$, and a preferable range is $0.1\leq SGI512/(SGI512+TP5)\leq 0.8$ and $0.1\leq SGI522/(SGI522+TP5)\leq 0.8$, where SGI512 is a displacement in parallel with the optical axis from a point on the object-side surface of the fifth lens, through which the optical axis passes, to an inflection point, which is the second closest to the optical axis, on the image-side surface of the fifth lens, and SGI522 is a displacement in parallel with the optical axis from a point on the object-side surface of the fifth lens, through which the optical axis passes, to an inflection point, which is the second closest to the optical axis, on the image-side surface of the fifth lens.

The optical image capturing system of the present invention satisfies $0.01\leq HIF511/HOI\leq 0.9$ and $0.01\leq HIF521/HOI\leq 0.9$, and a preferable range is $0.09\leq HIF511/HOI\leq 0.5$ and $0.09\leq HIF521/HOI\leq 0.5$, where HIF511 is a distance perpendicular to the optical axis between the inflection point, which is the closest to the optical axis, on the object-side surface of the fifth lens and the optical axis, and HIF521 is a distance perpendicular to the optical axis between the inflection point, which is the closest to the optical axis, on the image-side surface of the fifth lens and the optical axis.

The optical image capturing system of the present invention satisfies $0.01\leq HIF512/HOI\leq 0.9$ and $0.01\leq HIF522/HOI\leq 0.9$, and a preferable range is $0.09\leq HIF512/HOI\leq 0.8$ and $0.09\leq HIF522/HOI\leq 0.8$, where HIF512 is a distance perpendicular to the optical axis between the inflection point, which is the second the closest to the optical axis, on the object-side surface of the fifth lens and the optical axis, and HIF522 is a distance perpendicular to the optical axis between the inflection point, which is the second the closest to the optical axis, on the image-side surface of the fifth lens and the optical axis.

In an embodiment, the lenses of high Abbe number and the lenses of low Abbe number are arranged in an interlaced arrangement that could be helpful for correction of aberration of the system.

An equation of aspheric surface is

$$z=ch^2/[1+[1(k+1)c^2h^2]^{0.5}]+A4h^4+A6h^6+A8h^8+A10h^{10}+A12h^{12}+A14h^{14}+A16h^{16}+A18h^{18}+A20h^{20} \quad (1)$$

where z is a depression of the aspheric surface; k is conic constant; c is reciprocal of radius of curvature; and A4, A6, A8, A10, A12, A14, A16, A18, and A20 are high-order aspheric coefficients.

In the optical image capturing system, the lenses could be made of plastic or glass. The plastic lenses may reduce the weight and lower the cost of the system, and the glass lenses may control the thermal effect and enlarge the space for arrangement of refractive power of the system. In addition, the opposite surfaces (object-side surface and image-side surface) of the first to the fifth lenses could be aspheric that can obtain more control parameters to reduce aberration. The number of aspheric glass lenses could be less than the conventional spherical glass lenses that is helpful for reduction of the height of the system.

When the lens has a convex surface, which means that the surface is convex around a position, through which the optical axis passes, and when the lens has a concave surface, which means that the surface is concave around a position, through which the optical axis passes.

The optical image capturing system of the present invention further is provided with a diaphragm to increase image quality.

In the optical image capturing system, the diaphragm could be a front diaphragm or a middle diaphragm, wherein the front diaphragm is provided between the object and the first lens, and the middle is provided between the first lens and the image plane. The front diaphragm provides a long distance between an exit pupil of the system and the image plane, which allows more elements to be installed. The middle diaphragm could enlarge a view angle of view of the system and increase the efficiency of the image sensor. The middle diaphragm is helpful for size reduction and wide angle.

The optical image capturing system of the present invention could be applied in dynamic focusing optical system. It is superior in correction of aberration and high imaging quality so that it could be allied in lots of fields.

We provide several embodiments in conjunction with the accompanying drawings for the best understanding, which are:

First Embodiment

As shown in FIG. 1A and FIG. 1B, an optical image capturing system 100 of the first preferred embodiment of the present invention includes, along an optical axis from an object side to an image side, an aperture 100, a first lens 110, a second lens 120, a third lens 130, a fourth lens 140, a fifth lens 150, an infrared rays filter 170, an image plane 180, and an image sensor 190.

The first lens 110 has positive refractive power, and is made of plastic. An object-side surface 112 thereof, which faces the object side, is a convex aspheric surface, and an image-side surface 114 thereof, which faces the image side, is a concave aspheric surface, and the image-side surface has an inflection point. The first lens 110 satisfies SGI121=0.0387148 mm and |SGI121|/(|SGI121|+TP1)=0.061775374, where SGI121 is a displacement in parallel with the optical axis from a point on the image-side surface of the first lens, through which the optical axis passes, to the inflection point on the image-side surface, which is the closest to the optical axis.

The first lens 110 further satisfies HIF121=0.61351 mm and HIF121/HOI=0.209139253, where HIF121 is a displacement perpendicular to the optical axis from a point on the image-side surface of the first lens, through which the optical axis passes, to the inflection point, which is the closest to the optical axis.

The second lens 120 has negative refractive power, and is made of plastic. An object-side surface 122 thereof, which faces the object side, is a concave aspheric surface, and an image-side surface 124 thereof, which faces the image side, is a convex aspheric surface, and the image-side surface 124 has an inflection point. The second lens 120 satisfies SGI221=−0.0657553 mm and |SGI221|/(|SGI221|+TP2)=0.176581512, where SGI221 is a displacement in parallel with the optical axis from a point on the image-side surface of the second lens, through which the optical axis passes, to the inflection point on the image-side surface, which is the closest to the optical axis.

The second lens further satisfies HIF221=0.84667 mm and HIF221/HOI=0.288621101, where HIF221 is a displacement perpendicular to the optical axis from a point on the image-side surface of the second lens, through which the optical axis passes, to the inflection point, which is the closest to the optical axis.

The third lens 130 has negative refractive power, and is made of plastic. An object-side surface 132, which faces the object side, is a concave aspheric surface, and an image-side surface 134, which faces the image side, is a convex aspheric surface, and each of them has two inflection points. The third lens 130 satisfies SGI311=−0.341027 mm; SGI321=−0.231534 mm and |SGI311|/(|SGI311|+TP3)=0.525237108 and |SGI321|/(|SGI321|+TP3)=0.428934269, where SGI311 is a displacement in parallel with the optical axis, from a point on the object-side surface of the third lens, through which the optical axis passes, to the inflection point on the object-side surface, which is the closest to the optical axis, and SGI321 is a displacement in parallel with the optical axis, from a point on the image-side surface of the third lens, through which the optical axis passes, to the inflection point on the image-side surface, which is the closest to the optical axis.

The third lens 130 satisfies SGI312=−0.376807 mm; SGI322=−0.382162 mm; |SGI312|/(|SGI312|+TP5)=0.550033428; |SGI322|/(|SGI322|+TP3)=0.55352345, where SGI312 is a displacement in parallel with the optical axis, from a point on the object-side surface of the third lens, through which the optical axis passes, to the inflection point on the object-side surface, which is the second closest to the optical axis, and SGI322 is a displacement in parallel with the optical axis, from a point on the image-side surface of the third lens, through which the optical axis passes, to the inflection point on the image-side surface, which is the second closest to the optical axis.

The third lens 130 further satisfies HIF311=0.987648 mm; HIF321=0.805604 mm; HIF311/HOI=0.336679052; and HIF321/HOI=0.274622124, where HIF311 is a distance perpendicular to the optical axis between the inflection point on the object-side surface of the third lens, which is the closest to the optical axis, and the optical axis, and HIF321 is a distance perpendicular to the optical axis between the inflection point on the image-side surface of the third lens, which is the closest to the optical axis, and the optical axis.

The third lens 130 further satisfies HIF312=1.0493 mm; HIF322=1.17741 mm; HIF312/HOI=0.357695585; and HIF322/HOI=0.401366968, where HIF312 is a distance perpendicular to the optical axis between the inflection point on the object-side surface of the third lens, which is the second the closest to the optical axis, and the optical axis, and HIF322 is a distance perpendicular to the optical axis, between the inflection point on the image-side surface of the third lens, which is the second the closest to the optical axis, and the optical axis.

The fourth lens 140 has positive refractive power, and is made of plastic. Both an object-side surface 142, which faces the object side, and an image-side surface 144, which faces the image side, thereof are convex aspheric surfaces, and the object-side surface 142 has an inflection point. The fourth lens 140 satisfies SGI411=0.0687683 mm and |SGI411|/(|SGI411|+TP4)=0.118221297, where SGI411 is a displacement in parallel with the optical axis from a point on the object-side surface of the fourth lens, through which the optical axis passes, to the inflection point on the object-side surface, which is the closest to the optical axis.

The fourth lens 140 further satisfies HIF411=0.645213 mm and HIF411/HOI=0.21994648, where HIF411 is a distance perpendicular to the optical axis between the inflection point on the object-side surface of the fourth lens, which is the closest to the optical axis, and the optical axis.

The fifth lens 150 has negative refractive power, and is made of plastic. Both an object-side surface 152, which faces the object side, and an image-side surface 154, which faces the image side, thereof are concave aspheric surfaces. The object-side surface **152** has three inflection points, and the image-side surface **154** has an inflection point. The fifth lens **150** satisfies SGI511=−0.236079 mm; SGI521=0.023266 mm; |SGI511|/(|SGI511|+TP5)=0.418297214; and |SGI521|/(|SGI521|+TP5)=0.066177809, where SGI511 is a displacement in parallel with the optical axis, from a point on the object-side surface of the fifth lens, through which the optical axis passes, to the inflection point on the object-side surface, which is the closest to the optical axis, and SGI521 is a displacement in parallel with the optical axis, from a point on the image-side surface of the fifth lens, through which the optical axis passes, to the inflection point on the image-side surface, which is the closest to the optical axis.

The fifth lens **150** further satisfies SGI512=−0.325042 mm and |SGI512|/(|SGI512|+TP5)=0.497505143, where SGI512 is a displacement in parallel with the optical axis, from a point on the object-side surface of the fifth lens, through which the optical axis passes, to the inflection point on the object-side surface, which is the second closest to the optical axis.

The fifth lens **150** further satisfies SGI513=−0.538131 mm; and |SGI513|/(|SGI513|+TP5)=0.621087839, where SGI513 is a displacement in parallel with the optical axis, from a point on the object-side surface of the fifth lens, through which the optical axis passes, to the inflection point on the object-side surface, which is the third closest to the optical axis.

The fifth lens **150** further satisfies HIF511=1.21551 mm; HIF521=0.575738 mm; HIF511/HOI=0.414354866; and HIF521/HOI=0.196263167, where HIF511 is a distance perpendicular to the optical axis between the inflection point on the object-side surface of the fifth lens, which is the closest to the optical axis, and the optical axis, and HIF521 is a distance perpendicular to the optical axis between the inflection point on the image-side surface of the fifth lens, which is the closest to the optical axis, and the optical axis.

The fifth lens **150** further satisfies HIF512=1.49061 mm and HIF512/HOI=0.508133629, where HIF512 is a distance perpendicular to the optical axis between the inflection point on the object-side surface of the fifth lens, which is the second the closest to the optical axis, and the optical axis.

The fifth lens **150** further satisfies HIF513=2.00664 mm and HIF513/HOI=0.684042952, where HIF513 is a distance perpendicular to the optical axis between the inflection point on the object-side surface of the fifth lens, which is the third closest to the optical axis, and the optical axis.

The infrared rays filter **170** is made of glass, and between the fifth lens **150** and the image plane **180**. The infrared rays filter **170** gives no contribution to the focal length of the system.

The optical image capturing system of the first preferred embodiment has the following parameters, which are f=3.73172 mm; f/HEP=2.05; and HAF=37.5 degrees and tan(HAF)=0.7673, where f is a focal length of the system; HAF is a half of the maximum field angle; and HEP is an entrance pupil diameter.

The parameters of the lenses of the first preferred embodiment are f1=3.7751 mm; |f/f1|=0.9885; f5=−3.6601 mm; |f1|>f5; and |f1/f5|=1.0314, where f1 is a focal length of the first lens **110**; and f5 is a focal length of the fifth lens **150**.

The first preferred embodiment further satisfies |f2|+|f3|+|f4|=77.3594 mm; |f1|+|f5|=7.4352 mm; and |f2|+|f3|+|f4|>|f1|+|f5|, where f2 is a focal length of the second lens **120**; f3 is a focal length of the third lens **130**; and f4 is a focal length of the fourth lens **140**.

The optical image capturing system of the first preferred embodiment further satisfies ΣPPR=f/f1+f/f4=1.9785; ΣNPR=f/f2+f/f3+f/f5=−1.2901; ΣPPR/|ΣNPR|=1.5336; |f/f1|=0.9885; |f/f2|=0.0676; |f/f3|=0.2029; |f/f4|=0.9900; and |f/f5|=1.0196, where PPR is a ratio of a focal length f of the optical image capturing system to a focal length fp of each of the lenses with positive refractive power; and NPR is a ratio of a focal length f of the optical image capturing system to a focal length fn of each of lenses with negative refractive power.

The optical image capturing system of the first preferred embodiment further satisfies InTL+InB=HOS; HOS=4.5 mm; HOI=2.9335 mm; HOS/HOI=1.5340; HOS/f=1.2059; InTL/HOS=0.7597; InS=4.19216 mm; and InS/HOS=0.9316, where InTL is a distance between the object-side surface **112** of the first lens **110** and the image-side surface **154** of the fifth lens **150**; HOS is a height of the image capturing system, i.e., a distance between the object-side surface **112** of the first lens **110** and the image plane **180**; InS is a distance between the aperture **100** and the image plane **180**; HOI is height for image formation of the optical image capturing system, i.e., the maximum image height; and InB is a distance between the image-side surface **154** of the fifth lens **150** and the image plane **180**.

The optical image capturing system of the first preferred embodiment further satisfies ΣTP=2.044092 mm and ΣTP/InTL=0.5979, where ΣTP is a sum of the thicknesses of the lenses **110-150** with refractive power. It is helpful for the contrast of image and yield of manufacture, and provides a suitable back focal length for installation of other elements.

The optical image capturing system of the first preferred embodiment further satisfies |R1/R2|=0.3261, where R1 is a radius of curvature of the object-side surface **112** of the first lens **110**, and R2 is a radius of curvature of the image-side surface **114** of the first lens **110**. It provides the first lens with a suitable positive refractive power to reduce the increase rate of the spherical aberration.

The optical image capturing system of the first preferred embodiment further satisfies (R9−R10)/(R9+R10)=−2.9828, where R9 is a radius of curvature of the object-side surface **152** of the fifth lens **150**, and R10 is a radius of curvature of the image-side surface **154** of the fifth lens **150**. It may modify the astigmatic field curvature.

The optical image capturing system of the first preferred embodiment further satisfies ΣPP=f1+f4=7.5444 mm and f1/(f1+f4)=0.5004, where ΣPP is a sum of the focal lengths fp of each lens with positive refractive power. It is helpful to share the positive refractive power of the first lens **110** to the other positive lens to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the first preferred embodiment further satisfies ΣNP=f2+f3+f5=−77.2502 mm and f5/(f2+f3+f5)=0.0474, where f2, f3, and f5 are focal lengths of the second, the third, and the fifth lenses, and ΣNP is a sum of the focal lengths fn of each lens with negative refractive power. It is helpful to share the negative refractive power of the fifth lens **150** to other negative lenses to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the first preferred embodiment further satisfies IN12=0.511659 mm and IN12/f=0.1371, where IN12 is a distance on the optical axis between the first lens **110** and the second lens **120**. It may correct chromatic aberration and improve the performance.

The optical image capturing system of the first preferred embodiment further satisfies TP1=0.587988 mm; TP2=0.306624 mm; and (TP1+IN12)/TP2=3.5863, where TP1 is a central thickness of the first lens **110** on the optical axis, and TP2 is a central thickness of the second lens **120** on the optical axis. It may control the sensitivity of manufacture of the system and improve the performance.

The optical image capturing system of the first preferred embodiment further satisfies TP4=0.5129 mm; TP5=0.3283 mm; and (TP5+IN45)/TP4=1.5095, where TP4 is a central thickness of the fourth lens **140** on the optical axis, TP5 is a central thickness of the fifth lens **150** on the optical axis, and IN45 is a distance on the optical axis between the fourth lens and the fifth lens. It may control the sensitivity of manufacture of the system and improve the performance.

The optical image capturing system of the first preferred embodiment further satisfies TP3=0.3083 mm and (TP2+TP3+TP4)/ΣTP=0.5517, where TP2, TP3, and TP4 are thicknesses on the optical axis of the second, the third, and the fourth lenses, and ΣTP is a sum of the central thicknesses of all the lenses with refractive power on the optical axis. It may finely modify the aberration of the incident rays and reduce the height of the system.

The optical image capturing system of the first preferred embodiment further satisfies InRS51=−0.576871 mm; InRS52=−0.555284 mm; |InRS51|+|InRS52|=1.1132155 mm; |InRS51|/TP5=1.7571; and |InRS52|/TP5=1.691, where InRS51 is a displacement in parallel with the optical axis from a point on the object-side surface **152** of the fifth lens, through which the optical axis passes, to a point at the maximum effective semi diameter of the object-side surface **152** of the fifth lens; InRS52 is a displacement in parallel with the optical axis from a point on the image-side surface **154** of the fifth lens, through which the optical axis passes, to a point at the maximum effective semi diameter of the image-side surface **154** of the fifth lens; and TP5 is a central thickness of the fifth lens **150** on the optical axis. It is helpful for manufacturing and shaping of the lenses, and is helpful to reduce the size.

The second lens **120** and the fifth lens **150** of the optical image capturing system of the first preferred embodiment have negative refractive power, and the optical image capturing system further satisfies NA5/NA2=2.5441, where NA2 is an Abbe number of the second lens **120**, and NA5 is an Abbe number of the fifth lens **150**. It may correct the aberration of the system.

The optical image capturing system of the first preferred embodiment further satisfies |TDT|=0.6343% and |ODT|=2.5001%, where TDT is TV distortion; and ODT is optical distortion.

The parameters of the lenses of the first embodiment are listed in Table 1 and Table 2.

TABLE 1

f = 3.73172 mm; f/HEP = 2.05; HAF = 37.5 deg; tan(HAF) = 0.7673

Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
0	Object	plane	infinity				
1	Aperture	plane	−0.30784				
2	1st lens	1.48285	0.587988	plastic	1.5441	56.1	3.77514
3		4.54742	0.511659				
4	2nd lens	−9.33807	0.306624	plastic	1.6425	22.465	−55.2008
5		−12.8028	0.366935				
6	3rd lens	−1.02094	0.308255	plastic	1.6425	22.465	−18.3893
7		−1.2492	0.05				
8	4th lens	2.18916	0.512923	plastic	1.5441	56.1	3.7693
9		−31.3936	0.44596				
10	5th lens	−2.86353	0.328302	plastic	1.514	57.1538	−3.6601
11		5.75188	0.3				
12	Filter	plane	0.2		1.517	64.2	
13		plane	0.58424				
14	Image plane	plane	−0.00289				

Reference wavelength: 555 nm

TABLE 2

Coefficients of the aspheric surfaces

Surface	2	3	4	5	6
k	−1.83479	−20.595808	16.674705	11.425456	−4.642191
A4	6.89867E−02	2.25678E−02	−1.11828E−01	−4.19899E−02	−7.09315E−02
A6	2.35740E−02	−6.17850E−02	−6.62880E−02	−1.88072E−02	9.65840E−02
A8	−4.26369E−02	5.82944E−02	−3.35190E−02	−6.98321E−02	−7.32044E−03
A10	5.63746E−03	−2.73938E−02	−7.28886E−02	−1.13079E−02	−8.96740E−02
A12	7.46740E−02	−2.45759E−01	4.05955E−02	6.79127E−02	−3.70146E−02
A14	−6.93116E−02	3.43401E−01	1.60451E−01	2.83769E−02	5.00641E−02
A16	−2.04867E−02	−1.28084E−01	1.24448E−01	−2.45035E−02	7.50413E−02
A18	1.99910E−02	−2.32031E−02	−1.94856E−01	2.90241E−02	−5.10392E−02
A20					

Surface	7	8	9	10	11
k	−1.197201	−20.458388	−50	−2.907359	−50
A4	3.64395E−02	−1.75641E−02	−7.82211E−04	−1.58711E−03	−2.46339E−02

TABLE 2-continued

Coefficients of the aspheric surfaces					
A6	2.22356E−02	−2.87240E−03	−2.47110E−04	−3.46504E−03	6.61804E−04
A8	7.09828E−03	−2.56360E−04	−3.78130E−04	4.52459E−03	1.54143E−04
A10	5.05740E−03	7.39189E−05	−1.22232E−04	1.05841E−04	−2.83264E−05
A12	−4.51124E−04	−5.53116E−08	−1.50294E−05	−5.57252E−04	−5.78839E−06
A14	−1.84003E−03	8.16043E−06	−5.41743E−07	4.41714E−05	−2.91861E−07
A16	−1.28118E−03	2.10395E−06	2.98820E−07	1.80752E−05	8.25778E−08
A18	4.09004E−04	−1.21664E−06	2.73321E−07	−2.27031E−06	−9.87595E−09
A20					

The detail parameters of the first preferred embodiment are listed in Table 1, in which the unit of radius of curvature, thickness, and focal length are millimeter, and surface 0-14 indicates the surfaces of all elements in the system in sequence from the object side to the image side. Table 2 is the list of coefficients of the aspheric surfaces, in which A1-A20 indicate the coefficients of aspheric surfaces from the first order to the twentieth order of each aspheric surface. The following embodiments have the similar diagrams and tables, which are the same as those of the first embodiment, so we do not describe it again.

Second Embodiment

As shown in FIG. **2**A and FIG. **2**B, an optical image capturing system of the second preferred embodiment of the present invention includes, along an optical axis from an object side to an image side, a first lens **210**, an aperture **200**, a second lens **220**, a third lens **230**, a fourth lens **240**, a fifth lens **250**, an infrared rays filter **270**, an image plane **280**, and an image sensor **290**.

The first lens **210** has positive refractive power, and is made of plastic. An object-side surface **212** thereof, which faces the object side, is a concave aspheric surface, and an image-side surface **214** thereof, which faces the image side, is a convex aspheric surface, and each of them has an inflection point respectively.

The second lens **220** has negative refractive power, and is made of plastic. An object-side surface **222** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **224** thereof, which faces the image side, is a concave aspheric surface.

The third lens **230** has positive refractive power, and is made of plastic. An object-side surface **232**, which faces the object side, is a convex aspheric surface, and an image-side surface **234**, which faces the image side, is a convex aspheric surface. The object-side surface **232** has an inflection point thereon.

The fourth lens **240** has negative refractive power, and is made of plastic. An object-side surface **242** thereof, which faces the object side, is a concave aspheric surface, and an image-side surface **244** thereof, which faces the image side, is a convex aspheric surface. The object-side surface **242** and the image-side surface **244** both have two inflection points thereon.

The fifth lens **250** has negative refractive power, and is made of plastic. An object-side surface **252** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **254** thereof, which faces the image side, is a concave aspheric surface. The object-side surface **252** and the image-side surface **254** both have an inflection point.

The infrared rays filter **270** is made of glass, and between the fifth lens **250** and the image plane **280**. The infrared rays filter **270** gives no contribution to the focal length of the system.

The optical image capturing system of the second preferred embodiment has the following parameters, which are $|f2|+|f3|+|f4|=114.8894$ mm; $|f1|+|f5|=10.1200$ mm; and $|f2|+|f3|+|f4|>|f1|+|f5|$, where f1 is a focal length of the first lens **210**; f2 is a focal length of the second lens **220**; f3 is a focal length of the third lens **230**; f4 is a focal length of the fourth lens **240**; and f5 is a focal length of the fifth lens **250**.

The optical image capturing system of the second preferred embodiment further satisfies TP4=0.4410 mm and TP5=0.5313 mm, where TP4 is a thickness of the fourth lens on the optical axis, and TP5 is a thickness of the fifth lens on the optical axis.

In the second embodiment, the first and the third lenses **210**, **230** are positive lenses, and their focal lengths are f1 and f3 respectively. The optical image capturing system of the second preferred embodiment further satisfies $\Sigma PP=f1+f3=8.8653$ mm and $f1/(f1+f3)=0.7708$, where ΣPP is a sum of the focal lengths of each positive lens. It is helpful to share the positive refractive power of the first lens **210** to the other positive lens to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the second preferred embodiment further satisfies $\Sigma NP=f2+f4+f5=-116.1440$ mm and $f5/(f2+f4+f5)=0.1107$, where f2, f4 and f5 are focal lengths of the second lens **220**, the fourth lens **240**, and the fifth lenses **250**, and ΣNP is a sum of the focal lengths of each negative lens. It is helpful to share the negative refractive power of the fifth lens **250** to other negative lenses to avoid the significant aberration caused by the incident rays.

The parameters of the lenses of the second embodiment are listed in Table 3 and Table 4.

TABLE 3

f = 3.04499 mm; f/HEP = 1.4; HAF = 50.0014 deg; tan(HAF) = 1.1918

Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
0	Object	plane	infinity				
1	1^{st} lens	−11.5199	0.633953	plastic	1.65	21.4	6.83352

TABLE 3-continued

f = 3.04499 mm; f/HEP = 1.4; HAF = 50.0014 deg; tan(HAF) = 1.1918							
Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
2		−3.29534	0.539549				
3	Aperture	plane	−0.26732				
4	2^{nd} lens	5.32819	0.256081	plastic	1.514	56.8	−12.8556
5		2.90562	0.214751				
6	3^{rd} lens	5.76049	2.25	plastic	1.565	58	2.03175
7		−1.23591	0.068369				
8	4^{th} lens	−1.22369	0.44095	plastic	1.65	21.4	−100.002
9		−1.42488	0.43528				
10	5^{th} lens	20.15529	0.531272	plastic	1.583	30.2	−3.28643
11		1.74207	0.4				
12	Filter	plane	0.2		1.517	64.2	
13		plane	0.369886				
14	Image plane	plane	0.066676				

Reference wavelength: 555 nm. The clear aperture of the first surface is 1.7 mm; the clear aperture of the sixth surface is 1.0 mm

TABLE 4

Coefficients of the aspheric surfaces

	Surface 1	2	4	5	6	7
k =	−32.111489	−29.043197	20.538497	2.893875	7.796234	
A4 =	1.70448E−02	5.44336E−02	2.36690E−01	1.25318E−01	−1.94309E−02	9.12064E−02
A6 =	8.58212E−03	−1.58941E−02	−2.84178E−01	−2.75917E−01	3.54828E−02	−3.25066E−02
A8 =	−4.73154E−03	8.98647E−03	1.97091E−01	2.44372E−01	−9.14755E−02	1.21732E−02
A10 =	1.82736E−03	2.30323E−03	−3.05007E−02	−5.88377E−02	−1.34040E−02	−7.31762E−04
A12 =	−4.01244E−04	−3.78821E−03	−4.55037E−02	−6.05169E−02	1.12767E−01	−1.42096E−03
A14 =	4.46980E−05	1.21091E−03	2.24753E−02	3.46406E−02	−6.98898E−02	4.50126E−04

	Surface 8	9	10	11
k =	−0.529239	−0.595565	−50	−5.806512
A4 =	2.85489E−02	2.23253E−02	−8.92450E−02	−2.98001E−02
A6 =	2.77193E−02	5.27678E−03	2.78230E−02	5.50570E−03
A8 =	−7.88676E−04	5.95196E−03	−8.37179E−03	−8.32298E−04
A10 =	−7.39920E−04	−1.24426E−03	−4.17360E−05	4.58552E−05
A12 =	2.04814E−04	1.84562E−04	6.66916E−04	2.88566E−06
A14 =	7.88900E−05	−3.09911E−05	−1.11326E−04	−3.94115E−07

An equation of the aspheric surfaces of the second embodiment is the same as that of the first embodiment, and the definitions are the same as well.

The exact parameters of the second embodiment (with 555 nm as the main reference wavelength) based on Table 3 and Table 4 are listed in the following table:

|TDT|	1.0832%	InRS41	−0.8325
|ODT|	1.9986%	InRS42	−0.7040
ΣPP	8.8653	InRS51	−0.8519
ΣNP	−116.1440	InRS52	−0.4117
f1/ΣPP	0.7708	|InRS51|/TP5	1.4205
f5/ΣNP	0.1107	|InRS52|/TP5	0.6866
IN12/f	0.0894	(|InRS42| + |InRS51|)/IN45	3.5744
HOS/f	2.0162	HVT51	0.3839
HOS	6.1394	HVT52	1.8828

-continued

InTL	5.1029	HVT51/HOI	0.1026
HOS/HOI	1.6416	HVT52/HOI	0.5034
InS/HOS	0.8089	HVT52/HOS	0.3067
InTL/HOS	0.8312	|f/f1|	0.4456
ΣTP/InTL	0.8059	|f/f2|	0.2369
(TP1 + IN12)/TP2	3.5386	|f/f3|	1.4987
(TP5 + IN45)/TP4	2.1920	|f/f4|	0.0304
(TP2 + TP3 + TP4)/ΣTP	0.7166	|f/f5|	0.9265

The exact parameters related to inflection points of the second embodiment (with main reference wavelength as 555 nm) based on Table 3 and Table 4 are listed in the following table:

HIF111	0.54717	HIF111/HOI	0.14630	SGI111	−0.01105	|SGI111|/(|SGI111| + TP1)	0.01713
HIF121	0.50238	HIF121/HOI	0.13433	SGI121	−0.03027	|SGI121|/(|SGI121| + TP1)	0.04557
HIF311	0.65171	HIF311/HOI	0.17425	SGI311	0.03451	|SGI311|/(|SGI311| + TP3)	0.05162
HIF411	1.16832	HIF411/HOI	0.31239	SGI411	−0.51592	|SGI411|/(|SGI411| + TP4)	0.44868
HIF412	1.60870	HIF412/HOI	0.43013	SGI412	−0.80388	|SGI412|/(|SGI412| + TP4)	0.55909
HIF421	1.14342	HIF421/HOI	0.30573	SGI421	−0.43001	|SGI421|/(|SGI421| + TP4)	0.40416
HIF422	1.81927	HIF422/HOI	0.48644	SGI422	−0.70301	|SGI422|/(|SGI422| + TP4)	0.52583
HIF511	0.21828	HIF511/HOI	0.05836	SGI511	0.00098	|SGI511|/(|SGI511| + TP5)	0.00154
HIF521	0.84145	HIF521/HOI	0.22499	SGI521	0.15227	|SGI521|/(|SGI521| + TP5)	0.19367

Third Embodiment

As shown in FIG. **3**A and FIG. **3**B, an optical image capturing system of the third preferred embodiment of the present invention includes, along an optical axis from an object side to an image side, a first lens **310**, an aperture **300**, a second lens **320**, a third lens **330**, a fourth lens **340**, a fifth lens **350**, an infrared rays filter **370**, an image plane **380**, and an image sensor **390**.

The first lens **310** has positive refractive power, and is made of plastic. An object-side surface **312** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **314** thereof, which faces the image side, is a concave aspheric surface. The object-side surface **312** and the image-side surface **314** both have an inflection point thereon.

The second lens **320** has negative refractive power, and is made of plastic. An object-side surface **322** thereof, which faces the object side, is a convex aspheric surface; while an image-side surface **324** thereof, which faces the image side, is a concave aspheric surface. The object-side surface **322** and the image-side surface **324** both have an inflection point thereon.

The third lens **330** has positive refractive power, and is made of plastic. An object-side surface **332**, which faces the object side, is a concave aspheric surface, and an image-side surface **334**, which faces the image side, is a convex aspheric surface.

The fourth lens **340** has a negative refractive power, and is made of plastic. An object-side surface **342**, which faces the object side, is a concave aspheric surface, and an image-side surface **344**, which faces the image side, is a convex aspheric surface. The object-side surface **342** has two inflection points thereon.

The fifth lens **350** has negative refractive power, and is made of plastic. Both an object-side surface **352**, which faces the object side, and an image-side surface **354**, which faces the image side, thereof are concave aspheric surfaces. The object-side surface **352** has two inflection points, and the image-side surface **354** has an inflection point.

The infrared rays filter **370** is made of glass, and between the fifth lens **350** and the image plane **380**. The infrared rays filter **370** gives no contribution to the focal length of the system.

The parameters of the lenses of the third preferred embodiment are $|f2|+|f3|+|f4|=109.5899$ mm; $|f1|+|f5|=8.8602$ mm; and $|f2|+|f3|+|f4|>|f1|+|f5|$, where f1 is a focal length of the first lens **310**; f2 is a focal length of the second lens **320**; f3 is a focal length of the third lens **330**; and f4 is a focal length of the fourth lens **340**; and f5 is a focal length of the fifth lens **350**.

The optical image capturing system of the third preferred embodiment further satisfies TP4=0.5368 mm and TP5=0.3381 mm, where TP4 is a thickness of the fourth lens **340** on the optical axis, and TP5 is a thickness of the fifth lens **350** on the optical axis.

The optical image capturing system of the third preferred embodiment further satisfies $\Sigma PP=f1+f3=7.7668$ mm and $f1/(f1+f3)=0.7975$, where ΣPP is a sum of the focal lengths of each positive lens. It is helpful to share the positive refractive power of the first lens **310** to the other positive lens to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the third preferred embodiment further satisfies $\Sigma NP=f2+f4+f5=-110.6832$ mm and $f5/(f2+f4+f5)=0.9035$, where ΣNP is a sum of the focal lengths of each negative lens. It is helpful to share the negative refractive power of the fifth lens **350** to other lenses with negative refractive power.

The parameters of the lenses of the third embodiment are listed in Table 5 and Table 6.

TABLE 5

f = 3.12928 mm; f/HEP = 1.6; HAF = 49.9989 deg; tan(HAF) = 1.1917

Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
0	Object	plane	infinity				
1	1st lens	2.17479	0.439545	plastic	1.565	30.2	6.19403
2		5.01406	0.143529				
3	Aperture	plane	0.391924				
4	2^{nd} lens	21.87254	0.807168	plastic	1.565	58	−100
5		15.5714	0.198468				
6	3^{rd} lens	−10.4212	0.640669	plastic	1.565	58	1.57278
7		−0.83944	0.051804				
8	4^{th} lens	−1.01884	0.536834	plastic	1.565	26.6	−8.01707
9		−1.54344	0.683804				
10	5^{th} lens	−3.49326	0.338125	plastic	1.65	26.6	−2.66616
11		3.16565	0.3				
12	Filter	plane	0.2		1.517	64.2	

TABLE 5-continued

f = 3.12928 mm; f/HEP = 1.6; HAF = 49.9989 deg; tan(HAF) = 1.1917						
Surface	Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
13	plane	0.246045				
14 Image plane	plane	0.084534				

Reference wavelength: 555 nm. The clear aperture of the second surface is 1.15 mm; the clear aperture of the sixth surface is 1.4 mm

TABLE 6

Coefficients of the aspheric surfaces

Surface	1	2	4	5	6	7
k =	−14.410401	−27.502948	50	6.437629	38.56702	−2.357464
A4 =	1.54287E−01	4.25401E−02	−8.89025E−02	−4.61798E−02	−1.12970E−01	1.81107E−02
A6 =	−9.29394E−02	−5.19366E−02	9.02399E−02	−1.12820E−02	1.08679E−02	−1.57741E−02
A8 =	2.58799E−02	4.23595E−02	−1.61847E−01	−1.08748E−03	7.76558E−04	6.40568E−03
A10 =	2.28794E−02	1.79752E−02	3.72701E−02	−4.01437E−03	9.34479E−04	1.24315E−03
A12 =	−1.57336E−02	−6.17245E−02	9.09078E−02	−5.56028E−03	−7.06209E−04	−2.87684E−04
A14 =	2.20896E−05	2.49091E−02	−7.44749E−02	1.56050E−03	−5.68331E−04	−5.07523E−04

Surface	8	9	10	11
k	−2.236569	−0.498113	−1.402819	−14.974414
A4	1.23225E−01	6.71654E−03	−6.65366E−02	−2.32053E−02
A6	−1.26790E−02	6.90319E−03	2.01675E−02	2.95881E−03
A8	−2.22656E−02	3.26373E−04	−9.13378E−04	−2.22849E−04
A10	4.04064E−03	−1.81551E−04	−3.57198E−04	9.89530E−06
A12	3.16419E−03	−4.85787E−05	7.54275E−05	2.46777E−07
A14	−1.38314E−03	1.18225E−06	−6.96187E−06	−8.80462E−08

An equation of the aspheric surfaces of the third embodiment is the same as that of the first embodiment, and the definitions are the same as well.

The exact parameters of the third embodiment (with 555 nm as the main reference wavelength) based on Table 5 and Table 6 are listed in the following table:

|TDT|	1.3431%	InRS41	−0.8779
|ODT|	2.0776%	InRS42	−1.1739
ΣPP	7.7668	InRS51	−1.0157
ΣNP	−110.6832	InRS52	−0.4889
f1/ΣPP	0.7975	|InRS51|/TP5	1.6936
f5/ΣNP	0.9035	|InRS52|/TP5	0.8152
IN12/f	0.1711	(|InRS42| + |InRS51|)/IN45	3.2020

-continued

HOS/f	1.6178	HVT51	0
HOS	5.0625	HVT52	1.6048
InTL	4.2319	HVT51/HOI	0
HOS/HOI	1.3536	HVT52/HOI	0.4291
InS/HOS	0.8848	HVT52/HOS	0.3170
InTL/HOS	0.8359	|f/f1|	0.5052
ΣTP/InTL	0.6527	|f/f2|	0.0313
(TP1 + IN12)/TP2	1.2079	|f/f3|	1.9896
(TP5 + IN45)/TP4	1.9036	|f/f4|	0.3903
(TP2 + TP3 + TP4)/ΣTP	0.7185	|f/f5|	1.1737

The exact parameters related to inflection points of the second embodiment (with main reference wavelength as 555 nm) based on Table 5 and Table 6 are listed in the following table:

HIF111	1.08504	HIF111/HOI	0.29012	SGI111	0.29743	|SGI111|/(|SGI111| + TP1)	0.40358
HIF121	0.85686	HIF121/HOI	0.22911	SGI121	0.07451	|SGI121|/(|SGI121| + TP1)	0.14495
HIF211	0.21938	HIF211/HOI	0.05866	SGI211	0.00090	|SGI211|/(|SGI211| + TP2)	0.00205
HIF221	0.33007	HIF221/HOI	0.08825	SGI221	0.00294	|SGI221|/(|SGI221| + TP2)	0.00664
HIF411	0.68404	HIF411/HOI	0.18290	SGI411	−0.17957	|SGI411|/(|SGI411| + TP4)	0.29004
HIF412	1.04281	HIF412/HOI	0.27883	SGI412	−0.31721	|SGI412|/(|SGI412| + TP4)	0.41917
HIF511	1.49205	HIF511/HOI	0.39894	SGI511	−0.45491	|SGI511|/(|SGI511| + TP5)	0.50859
HIF512	1.95532	HIF512/HOI	0.52281	SGI512	−0.71100	|SGI512|/(|SGI512| + TP5)	0.61797
HIF521	0.75369	HIF521/HOI	0.20152	SGI521	0.06976	|SGI521|/(|SGI521| + TP5)	0.13697

Fourth Embodiment

As shown in FIG. **4**A and FIG. **4**B, an optical image capturing system of the fourth preferred embodiment of the present invention includes, along an optical axis from an object side to an image side, an aperture **400**, a first lens **410**, a second lens **420**, a third lens **430**, a fourth lens **440**, a fifth lens **450**, an infrared rays filter **470**, an image plane **480**, and an image sensor **490**.

The first lens **410** has positive refractive power, and is made of plastic. An object-side surface **412** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **414** thereof, which faces the image side, is a convex aspheric surface. The image-side surface **414** has an inflection point thereon.

The second lens **420** has negative refractive power, and is made of plastic. An object-side surface **422** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **424** thereof, which faces the image side, is a concave aspheric surface. The image-side surface **424** has an inflection point.

The third lens **430** has positive refractive power, and is made of plastic. An object-side surface **432**, which faces the object side, is a concave aspheric surface, and an image-side surface **434**, which faces the image side, is a convex aspheric surface.

The fourth lens **440** has negative refractive power, and is made of plastic. An object-side surface **442**, which faces the object side, is a concave aspheric surface, and an image-side surface **444**, which faces the image side, is a convex aspheric surface. The object-side surface **442** and the image-side surface **444** both have an inflection point.

The fifth lens **450** has negative refractive power, and is made of plastic. An object-side surface **452** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **454** thereof, which faces the image side, is a concave aspheric surface, and each of them has an inflection point.

The infrared rays filter **470** is made of glass, and between the fifth lens **450** and the image plane **480**. The infrared rays filter **470** gives no contribution to the focal length of the system.

The optical image capturing system of the fourth preferred embodiment has the following parameters, which are $|f2|+|f3|+|f4|=203.9003$ mm; $|f1|+|f5|=22.2372$ mm; and $|f2|+|f3|+|f4|>|f1|+|f5|$, where f1 is a focal length of the first lens **410**; f2 is a focal length of the second lens **420**; f3 is a focal length of the third lens **430**; f4 is a focal length of the fourth lens **440**; and f5 is a focal length of the fifth lens **450**.

The optical image capturing system of the fourth preferred embodiment further satisfies TP4=0.9894 mm and TP5=1.2227 mm, where TP4 is a thickness of the fourth lens on the optical axis, and TP5 is a thickness of the fifth lens on the optical axis.

In the fourth embodiment, the first and the third lenses **410**, **430** are positive lenses, and their focal lengths are f1 and f3 respectively. The optical image capturing system of the fourth preferred embodiment further satisfies $\Sigma PP=f1+f3=9.5002$ mm and $f1/(f1+f3)=0.5894$, where ΣPP is a sum of the focal lengths of each positive lens. It is helpful to share the positive refractive power of the first lens **410** to the other positive lens to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the fourth preferred embodiment further satisfies $\Sigma NP=f2+f4+f5=-216.6373$ mm and $f5/(f2+f4+f5)=0.4616$, where f2, f4 and f5 are focal lengths of the second, the fourth and the fifth lenses **420**, **440**, **450**, and ΣNP is a sum of the focal lengths of each negative lens. It is helpful to share the negative refractive power of the fifth lens **450** to other negative lenses to avoid the significant aberration caused by the incident rays.

The parameters of the lenses of the fourth embodiment are listed in Table 7 and Table 8.

TABLE 7

f = 3.01798 mm; f/HEP = 1.8; HAF = 50.0004 deg; tan(HAF) = 1.1919

Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
0	Object	plane	infinity				
1	1^{st} lens	3.75369	0.4562	plastic	1.65	21.4	5.59985
2		−157.435	0.113279				
3	Aperture	plane	−0.06648				
4	2^{nd} lens	28.90376	0.320317	plastic	1.514	56.8	−100
5		18.45196	0.201419				
6	3^{rd} lens	−31.8535	0.659507	plastic	1.565	58	3.90033
7		−2.08265	0.205949				
8	4^{th} lens	−1.26402	0.989365	plastic	1.607	26.6	−100
9		−1.67392	0.22823				
10	5^{th} lens	2.3755	1.222658	plastic	1.65	21.4	−16.6373
11		1.55309	0.6				
12	Filter	plane	0.2		1.517	64.2	
13		plane	0.195782				
14	Image plane	plane	0.096747				

Reference wavelength: 555 nm

TABLE 8

Coefficients of the aspheric surfaces						
	Surface					
	1	2	4	5	6	7
k =	−8.042882	50	−50	−47.982794	50	−26.437942
A4 =	6.82441E−03	1.30006E−01	1.99202E−01	5.30446E−06	−9.18258E−02	−3.38060E−01
A6 =	5.97843E−02	2.24690E−01	−1.37348E−01	−1.93461E−01	2.72351E−01	3.40964E−01
A8 =	−9.56620E−02	−1.34470E+00	−5.66653E−02	2.40029E−01	−1.23632E+00	−2.61390E−01
A10 =	9.72689E−02	3.39344E+00	4.89504E−01	−8.80032E−02	2.19953E+00	−2.16524E−01
A12 =	−5.24899E−02	−4.04253E+00	−8.06183E−01	−4.32311E−01	−1.96382E+00	3.49961E−01
A14 =	1.21078E−02	1.93995E+00	5.17467E−01	4.28065E−01	5.82683E−01	−1.40299E−01

	Surface			
	8	9	10	11
k	0.13763	−0.321395	−37.255342	−6.398451
A4	5.12102E−02	−1.73098E−01	−6.68346E−02	−2.17676E−02
A6	−1.99088E−01	2.26228E−01	1.16924E−02	2.88036E−03
A8	4.32664E−01	−1.85927E−01	−3.24423E−03	−2.62255E−04
A10	−6.02790E−01	9.15231E−02	3.68664E−04	2.75067E−06
A12	3.21026E−01	−2.53160E−02	−3.20460E−05	9.15856E−07
A14	−1.49719E−02	3.44062E−03	1.84028E−06	−4.79682E−08

An equation of the aspheric surfaces of the fourth embodiment is the same as that of the first embodiment, and the definitions are the same as well.

The exact parameters of the fourth embodiment (with 555 nm as the main reference wavelength) based on Table 7 and Table 8 are listed in the following table:

|TDT|	0.2212%	InRS51	−0.6850
|ODT|	2.0284%	InRS52	−0.8720
ΣPP	9.5002	|InRS51|/TP5	−0.3890
ΣNP	−216.6373	|InRS52|/TP5	0.0034
f1/ΣPP	0.5894	HIF511	0.6487
f5/ΣNP	0.4616	HIF512	0.0056
IN12/f	0.0155	HIF521	5.5250
HOS/f	1.7969	HIF522	0.8731
HOS	5.4230	HIF311	2.0611
InTL	4.3305	HIF312	0.2334
HOS/HOI	1.4500	HIF321	0.5511
InS/HOS	0.8950	HIF322	0.3801
InTL/HOS	0.7985	|f/f1|	0.5389
ΣTP/InTL	0.8424	|f/f2|	0.0302
(TP1 + IN12)/TP2	1.5703	|f/f3|	0.7738
(TP5 + IN45)/TP5	1.4665	|f/f4|	0.0302
(TP2 + TP3 + TP4)/ΣTP	0.5398	|f/f5|	0.1814

The exact parameters related to inflection points of the second embodiment (with main reference wavelength as 555 nm) based on Table 7 and Table 8 are listed in the following table:

HIF121	0.06326	HIF121/HOI	0.01691	SGI121	−0.00001	|SGI121|/(|SGI121| + TP1)	0.00002
HIF211	0.32945	HIF211/HOI	0.08809	SGI211	0.00271	|SGI211|/(|SGI211| + TP2)	0.00591
HIF212	0.85797	HIF212/HOI	0.22940	SGI212	−0.02489	|SGI212|/(|SGI212| + TP2)	0.05174
HIF411	1.01806	HIF411/HOI	0.27221	SGI411	−0.55195	|SGI411|/(|SGI411| + TP4)	0.54749
HIF421	1.29897	HIF421/HOI	0.34732	SGI421	−0.68143	|SGI421|/(|SGI421| + TP4)	0.59899
HIF511	0.42332	HIF511/HOI	0.11319	SGI511	0.02850	|SGI511|/(|SGI511| + TP5)	0.05880
HIF521	0.85509	HIF521/HOI	0.22863	SGI521	0.16885	|SGI521|/(|SGI521| + TP5)	0.27014

Fifth Embodiment

As shown in FIG. **5**A and FIG. **5**B, an optical image capturing system of the fifth preferred embodiment of the present invention includes, along an optical axis from an object side to an image side, a first lens **510**, an aperture **500**, a second lens **520**, a third lens **530**, a fourth lens **540**, a fifth lens **550**, an infrared rays filter **570**, an image plane **580**, and an image sensor **590**.

The first lens **510** has positive refractive power, and is made of plastic. An object-side surface **512** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **514** thereof, which faces the image side, is a concave aspheric surface.

The second lens **520** has negative refractive power, and is made of plastic. An object-side surface **522** thereof, which faces the object side, is a convex aspheric surface, and an image-side surface **524** thereof, which faces the image side, is a concave aspheric surface. The object-side surface **522** and the image-side surface **524** both have an inflection point thereon.

The third lens **530** has positive refractive power, and is made of plastic. An object-side surface **532**, which faces the object side, is a convex aspheric surface, and an image-side surface **534**, which faces the image side, is a convex aspheric surface. The object-side surface **532** has an inflection point.

The fourth lens **540** has a negative refractive power, and is made of plastic. An object-side surface **542**, which faces the object side, is a concave aspheric surface, and an image-side surface **544**, which faces the image side, is a convex aspheric surface. The image-side surface **544** has an inflection point thereon.

The fifth lens **550** has negative refractive power, and is made of plastic. An object-side surface **552**, which faces the object side, is a concave aspheric surface, and an image-side surface **554**, which faces the image side, thereof is a concave aspheric surface. The image-side surface **554** has an inflection point thereon.

The infrared rays filter **570** is made of glass, and between the fifth lens **550** and the image plane **580**. The infrared rays filter **570** gives no contribution to the focal length of the system.

The parameters of the lenses of the fifth preferred embodiment are |f2|+|f3|+|f4|=108.0843 mm; |f1|+|f5|=8.2967 mm; and |f2|+|f3|+|f4|>|f1|+|f5|, where f1 is a focal length of the first lens **510**; f2 is a focal length of the second lens **520**; f3 is a focal length of the third lens **530**; and f4 is a focal length of the fourth lens **540**; and f5 is a focal length of the fifth lens **550**.

The optical image capturing system of the fifth preferred embodiment further satisfies TP4=0.5988 mm and TP5=0.3481 mm, where TP4 is a thickness of the fourth lens **540** on the optical axis, and TP5 is a thickness of the fifth lens **550** on the optical axis.

The optical image capturing system of the fifth preferred embodiment further satisfies ΣPP=f1+f3=7.5999 mm and f1/(f1+f3)=0.7905, where ΣPP is a sum of the focal lengths of each positive lens. It is helpful to share the positive refractive power of the first lens **510** to the other positive lens to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the fifth preferred embodiment further satisfies ΣNP=f2+f4+f5=−108.7810 mm; and f5/(f2+f4+f5)=0.0597, where ΣNP is a sum of the focal lengths of each negative lens. It is helpful to share the negative refractive power of the fifth lens **550** to other negative lenses.

The parameters of the lenses of the fifth embodiment are listed in Table 9 and Table 10.

TABLE 9

f = 3.06494 mm; f/HEP = 2.0; HAF = 50 deg; tan(HAF) = 1.1918

Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
0	Object	plane	infinity				
1	1^{st} lens	3.66747	0.431952	plastic	1.632	23.4	6.00737
2		84.562	0.069027				
3	Aperture	plane	−0.01908				
4	2^{nd} lens	2.69269	0.2	plastic	1.607	23.4	−6.49171
5		1.55934	0.100242				
6	3^{rd} lens	4.70055	2.25	plastic	1.565	58	1.59254
7		−0.9237	0.05				
8	4^{th} lens	−1.04152	0.598757	plastic	1.65	21.4	−100
9		−1.29923	0.585336				
10	5^{th} lens	−3.36408	0.348098	plastic	1.607	23.4	−2.28928
11		2.49287	0.5				
12	Filter	plane	0.2		1.517	64.2	
13		plane	0.187776				
14	Image plane	plane	0.067146				

Reference wavelength: 555 nm

TABLE 10

Coefficients of the aspheric surfaces

Surface	1	2	4	5	6	7
k =	−20.409862	−50	−25.275868	−10.360545	15.506475	−1.645885
A4 =	8.72174E−02	1.82767E−01	−6.50662E−02	1.40014E−03	−3.72628E−02	6.80061E−02
A6 =	1.86456E−01	−3.08069E−01	2.56544E−01	−5.81609E−02	3.26572E−02	−5.70807E−02
A8 =	−6.39583E−01	1.58756E+00	−9.80983E−01	1.80683E−01	1.28574E−01	8.54659E−03
A10 =	1.16587E+00	−4.39910E+00	1.51705E+00	−5.94848E−01	−4.63607E−01	1.64631E−03
A12 =	−1.01280E+00	6.21485E+00	−1.09419E+00	7.61806E−01	4.88346E−01	−1.35234E−03
A14 =	3.60468E−01	−3.31305E+00	2.97785E−01	−3.55213E−01	−1.85360E−01	2.38182E−04

Surface	8	9	10	11
k	−1.405897	−0.666247	0.996858	−5.109491
A4	−1.32198E−02	−4.25923E−03	1.02826E−02	−2.56356E−02
A6	5.70140E−03	1.40484E−02	−1.41432E−02	2.23066E−03
A8	−2.17676E−03	2.25448E−03	3.68819E−03	−1.30581E−04
A10	1.30469E−03	3.95482E−06	−5.04344E−04	−6.10154E−07
A12	6.51734E−04	−4.82939E−05	1.09487E−04	−1.25194E−07
A14	−3.69938E−04	−1.45207E−06	−2.43801E−05	−2.78538E−08

An equation of the aspheric surfaces of the fifth embodiment is the same as that of the first embodiment, and the definitions are the same as well.

The exact parameters of the fifth embodiment (with 555 nm as the main reference wavelength) based on Table 9 and Table 10 are listed in the following table:

|TDT|	1.2047%	InRS51	−0.9424
|ODT|	1.7653%	InRS52	−0.9303
ΣPP	7.5999	|InRS51|/TP5	−1.0443
ΣNP	−108.7810	|InRS52|/TP5	−0.4238
f1/ΣPP	0.7905	HIF511	1.7413
f5/ΣNP	0.0597	HIF512	0.7067
IN12/f	0.0163	HIF521	3.3735
HOS/f	1.8171	HIF522	0
HOS	5.5693	HIF311	1.7902
InTL	4.6143	HIF312	0
HOS/HOI	1.4891	HIF321	0.4787
InS/HOS	0.9100	HIF322	0.3214
InTL/HOS	0.8285	|f/f1|	0.5102
ΣTP/InTL	0.8298	|f/f2|	0.4721
(TP1 + IN12)/TP2	2.4095	|f/f3|	1.9246
(TP5 + IN45)/TP5	1.5590	|f/f4|	0.0306
(TP2 + TP3 + TP4)/ΣTP	0.7963	|f/f5|	1.3388

The exact parameters related to inflection points of the second embodiment (with main reference wavelength as 555 nm) based on Table 9 and Table 10 are listed in the following table:

HIF211	0.48874	HIF211/HOI	0.13068	SGI211	0.03546	|SGI211|/(|SGI211| + TP2)	0.07587
HIF221	0.59692	HIF221/HOI	0.15961	SGI221	0.08830	|SGI221|/(|SGI221| + TP2)	0.16973
HIF311	0.88930	HIF311/HOI	0.23778	SGI311	0.08594	|SGI311|/(|SGI311| + TP3)	0.16595
HIF421	1.24150	HIF421/HOI	0.33195	SGI421	−0.59352	|SGI421|/(|SGI421| + TP4)	0.57878
HIF521	0.90250	HIF521/HOI	0.24131	SGI521	0.12998	|SGI521|/(|SGI521| + TP5)	0.23131

Sixth Embodiment

As shown in FIG. **6**A and FIG. **6**B, an optical image capturing system of the sixth preferred embodiment of the present invention includes, along an optical axis from an object side to an image side, a first lens **610**, an aperture **600**, a second lens **620**, a third lens **630**, a fourth lens **640**, a fifth lens **650**, an infrared rays filter **670**, an image plane **680**, and an image sensor **690**.

The first lens **610** has positive refractive power, and is made of plastic. An object-side surface **612**, which faces the object side, is a convex aspheric surface, and an image-side surface **614** thereof, which faces the image side, is a concave aspheric surface.

The second lens **620** has negative refractive power, and is made of plastic. An object-side surface thereof, which faces the object side, is a convex aspheric surface, and an image-side surface thereof, which faces the image side, is a concave aspheric surface. The object-side surface **622** and the image-side surface **624** both has an inflection point thereon.

The third lens **630** has positive refractive power, and is made of plastic. An object-side surface **632**, which faces the object side, is a convex aspheric surface, and an image-side surface **634**, which faces the image side, is a convex aspheric surface. The object-side surface **632** has an inflection point thereon.

The fourth lens **640** has negative refractive power, and is made of plastic. An object-side surface **642**, which faces the object side, is a concave aspheric surface, and an image-side surface **644**, which faces the image side, is a convex aspheric surface. The object-side surface **642** has an inflection point thereon.

The fifth lens **650** has negative refractive power, and is made of plastic. An object-side surface **652**, which faces the object side, is a concave aspheric surface, and an image-side surface **654**, which faces the image side, thereof is a concave aspheric surface. The image-side surface **654** has an inflection point thereon.

The infrared rays filter **670** is made of glass, and between the fifth lens **650** and the image plane **680**. The infrared rays filter **670** gives no contribution to the focal length of the system.

The optical image capturing system of the sixth preferred embodiment has the following parameters, which are |f2|+|f3|+|f4|=201.6178 mm; |f1|+|f5|=8.4371 mm; and |f2|+|f3|+1f4|>|f1|+|f5|, where f1 is a focal length of the first lens **610**; f2 is a focal length of the second lens **620**; f3 is a focal length of the third lens **630**; f4 is a focal length of the fourth lens **640**; and f5 is a focal length of the fifth lens **650**.

The optical image capturing system of the sixth preferred embodiment further satisfies TP4=0.7356 mm and TP5=0.3985 mm, where TP4 is a thickness of the fourth lens on the optical axis, and TP5 is a thickness of the fifth lens on the optical axis.

In the sixth embodiment, the first and the third lenses **610**, **630** are positive lenses, and their focal lengths are f1 and f3 respectively. The optical image capturing system of the sixth preferred embodiment further satisfies ΣPP=f1+f3=8.0203 mm and f1/(f1+f3)=0.7983, where ΣPP is a sum of the focal lengths of each positive lens. It is helpful to share the positive refractive power of the first lens **610** to the other positive lens to avoid the significant aberration caused by the incident rays.

The optical image capturing system of the sixth preferred embodiment further satisfies ΣNP=f2+f4+f5=−202.0346 mm and f5/(f2+f4+f5)=0.4950, where f2, f4 and f5 are focal lengths of the second, the fourth and the fifth lenses, and ΣNP is a sum of the focal lengths of each negative lens. It is helpful to share the negative refractive power of the fifth lens **650** to other negative lenses to avoid the significant aberration caused by the incident rays.

The parameters of the lenses of the sixth embodiment are listed in Table 11 and Table 12.

TABLE 11

f = 2.97861 mm; f/HEP = 1.4; HAF = 50.0001 deg; tan(HAF) = 1.1918							
Surface		Radius of curvature (mm)	Thickness (mm)	Material	Refractive index	Abbe number	Focal length (mm)
0	Object	plane	infinity				
1	1^{st} lens	2.3988	0.456243	plastic	1.565	58	6.40246
2		6.5902	0.08838				
3	Aperture	plane	0.411254				
4	2^{nd} lens	144.6516	0.349143	plastic	1.565	58	−100
5		40.68654	0.084996				
6	3^{rd} lens	24.44361	0.808138	plastic	1.583	30.2	1.61783
7		−0.97508	0.05				
8	4^{th} lens	−0.85898	0.735623	plastic	1.565	58	−100
9		−1.1424	0.685879				
10	5^{th} lens	−4.05486	0.39853	plastic	1.65	21.4	−2.0346
11		2.06441	0.3				
12	Filter	plane	0.2		1.517	64.2	
13		plane	0.203492				
14	Image plane	plane	0.160725				

Reference wavelength: 555 nm. The clear aperture of the first surface is 1.22 mm; the clear aperture of the sixth surface is 1.03 mm.

TABLE 12

Coefficients of the aspheric surfaces

Surface	1	2	4	5	6	7
k =	−21.439717	−1.976571	50	7.326364	47.916247	−2.428818
A4 =	1.48662E−01	8.76887E−03	−1.52157E−01	−2.00834E−01	−2.41634E−01	−2.12630E−02
A6 =	−7.96597E−02	6.85471E−02	2.42208E−01	2.68748E−02	2.13077E−01	6.92905E−02
A8 =	−1.58109E−02	−2.96673E−01	−4.66625E−01	3.06661E−02	−4.51221E−01	−4.92997E−02
A10 =	7.81152E−02	5.44324E−01	2.82724E−01	−2.44715E−01	3.10208E−01	−2.32974E−02
A12 =	−4.98017E−02	−4.52039E−01	5.24873E−02	2.50479E−01	−3.36706E−02	3.25165E−02
A14 =	1.00061E−02	1.38629E−01	−1.42016E−01	−9.17983E−02	−2.81886E−02	−1.01056E−02

Surface	8	9	10	11
k	−1.394704	−3.03247	−39.215327	−17.127864
A4	2.18458E−01	−1.62687E−02	−1.21846E−01	−2.08246E−02
A6	−1.66227E−02	−9.55726E−03	5.40811E−02	−1.91521E−04
A8	−3.17545E−02	1.15509E−02	−3.24253E−02	1.61481E−04
A10	1.19463E−04	−9.11869E−03	2.40979E−03	−2.19374E−06
A12	9.03458E−03	4.52160E−03	3.49318E−03	−1.72409E−06
A14	−2.85089E−03	−8.94094E−04	−8.19111E−04	8.06517E−08

An equation of the aspheric surfaces of the sixth embodiment is the same as that of the first embodiment, and the definitions are the same as well.

The exact parameters of the sixth embodiment based on Table 11 and Table 12 are listed in the following table:

|TDT|	1.4440%	InRS51	−0.5252
|ODT|	2.0614%	InRS52	−0.9300
ΣPP	8.0203	|InRS51|/TP5	−1.1956
ΣNP	−202.0346	|InRS52|/TP5	−0.4795
f1/ΣPP	0.7983	HIF511	1.9937
f6/ΣNP	0.4950	HIF521	0.7996
IN12/f	0.1677	HIF522	3.0991
HOS/f	1.6559	HIF523	0
HOS	4.9324	HIF311	1.4260
InTL	4.0682	HIF312	0

-continued

HOS/HOI	1.3188	HIF321	0.3813
InS/HOS	0.8896	HIF322	0.2891
InTL/HOS	0.8248	|f/f1|	0.4652
ΣTP/InTL	0.6754	|f/f2|	0.0298
(TP1 + IN12)/TP2	2.7378	|f/f3|	1.8411
(TP5 + IN45)/TP4	1.4741	|f/f4|	0.0298
(TP2 + TP3 + TP4)/ΣTP	0.6889	|f/f5|	1.4640

The exact parameters related to inflection points of the second embodiment (with main reference wavelength as 555 nm) based on Table 11 and Table 12 are listed in the following table:

HIF211	0.06201	HIF211/HOI	0.01658	SGI211	0.00001	|SGI211|/(|SGI211| + TP2)	0.00002
HIF221	0.10119	HIF221/HOI	0.02706	SGI221	0.00010	|SGI221|/(|SGI221| + TP2)	0.00023
HIF311	0.12076	HIF311/HOI	0.03229	SGI311	0.00025	|SGI311|/(|SGI311| + TP3)	0.00054
HIF411	0.63436	HIF411/HOI	0.16961	SGI411	−0.18934	|SGI411|/(|SGI411| + TP4)	0.29328
HIF412	1.15844	HIF412/HOI	0.30974	SGI412	−0.39491	|SGI412|/(|SGI412| + TP4)	0.46397
HIF521	0.66495	HIF521/HOI	0.17779	SGI521	0.07720	|SGI521|/(|SGI521| + TP5)	0.14472

It must be pointed out that the embodiments described above are only some preferred embodiments of the present invention. All equivalent structures which employ the concepts disclosed in this specification and the appended claims should fall within the scope of the present invention.

What is claimed is:

1. An optical image capturing system, in order along an optical axis from an object side to an image side, comprising:

a first lens having positive refractive power;

a second lens having refractive power;

a third lens having refractive power;

a fourth lens having negative refractive power;

a fifth lens having refractive power; and

an image plane;

wherein the optical image capturing system consists of the five lenses with refractive power; at least two of the five lenses each has at least an inflection point on at least a surface thereof; at least one of the lenses from the second lens to the fifth lens has positive refractive power; the fifth lens has an object-side surface, which faces the object side, and an image-side surface, which faces the image side, and both the object-side surface and the image-side surface of the fifth lens are aspheric surfaces;

wherein the optical image capturing system satisfies:

$$1.2 \leq f/HEP \leq 3.0; \text{ and}$$

$$0.5 \leq HOS/f \leq 3.0;$$

where f is a focal length of the optical image capturing system; HEP is an entrance pupil diameter of the optical image capturing system; and HOS is a distance in parallel with the optical axis from an object-side surface of the first lens to the image plane;

wherein the second lens has negative refractive power, and the fifth lens has negative refractive power.

2. The optical image capturing system of claim **1**, wherein the optical image capturing system further satisfies:

$$0 \text{ deg} < HAF \leq 70 \text{ deg};$$

$$|TDT| < 60\%; \text{ and}$$

$$|ODT| < 50\%;$$

where HAF is a half of a view angle of the optical image capturing system; TDT is a TV distortion; and ODT is an optical distortion.

3. The optical image capturing system of claim **1**, wherein the fifth lens has at least an inflection point on at least one of the surfaces thereof.

4. The optical image capturing system of claim **1**, wherein the optical image capturing system further satisfies:

$$0 \text{ mm} < HIF \leq 5 \text{ mm};$$

where HIF is a distance perpendicular to the optical axis between any inflection point and the optical axis.

5. The optical image capturing system of claim **4**, wherein the optical image capturing system further satisfies:

$$0 < HIF/InTL \leq 5;$$

where InTL is a distance in parallel with the optical axis between the object-side surface of the first lens and the image-side surface of the fifth lens.

6. The optical image capturing system of claim **5**, further comprising an aperture and an image sensor on the image plane, wherein the optical image capturing system further satisfies:

$$0.5 \leq InS/HOS \leq 1.1; \text{ and}$$

$$0 < HIF/HOI \leq 0.9;$$

where InS is a distance in parallel with the optical axis between the aperture and the image plane; and HOI is a height for an image formation of the optical image capturing system.

7. The optical image capturing system of claim **4**, wherein the optical image capturing system further satisfies:

$$0 \text{ mm} < SGI \leq 1 \text{ mm};$$

where SGI is a displacement in parallel with the optical axis from a point on a surface of the lens, through which the optical axis passes, to the inflection point on the surface.

8. The optical image capturing system of claim **1**, wherein the optical image capturing system further satisfies:

$$0.6 \leq InTL/HOS \leq 0.9;$$

where InTL is a distance in parallel with the optical axis between the object-side surface of the first lens and the image-side surface of the fifth lens.

9. An optical image capturing system, in order along an optical axis from an object side to an image side, comprising:

a first lens having positive refractive power;

a second lens having refractive power;

a third lens having refractive power;

a fourth lens having negative refractive power;

a fifth lens having negative refractive power; and

an image plane;

wherein the optical image capturing system consists of the five lenses with refractive power; at least two of the five lenses each has at least an inflection point on at least a surface thereof; at least one of the lenses from the second lens to the fourth lens has positive refractive power; the fifth lens has an object-side surface, which faces the object side, and an image-side surface, which faces the image side, and both the object-side surface and the image-side surface of the fifth lens are aspheric surfaces;

wherein the optical image capturing system satisfies:

$$1.2 \leq f/HEP \leq 3.0;$$

$$0.5 \leq HOS/f \leq 3.0;$$

$$0.4 \leq |\tan(HAF)| \leq 3.0;$$

$|TDT|<60\%$; and

$|ODT|\leq 50\%$;

where f1, f2, f3, f4, and f5 are focal lengths of the first lens to the fifth lens, respectively; f is a focal length of the optical image capturing system; HEP is an entrance pupil diameter of the optical image capturing system; HOS is a distance in parallel with the optical axis between an object-side surface, which face the object side, of the first lens and the image plane; HAF is a half of a view angle of the optical image capturing system; TDT is a TV distortion; and ODT is an optical distortion;

wherein the optical image capturing system further satisfies:

$0<SGI521/(TP5+SGI521)\leq 0.8$,

where SGI521 is a displacement in parallel with the optical axis from a point on the image-side surface of the fifth lens, through which the optical axis passes, to the inflection point, which is the closest to the optical axis, on the image-side surface of the fifth lens; and TP5 is a thickness of the fifth lens on the optical axis.

10. The optical image capturing system of claim **9**, wherein at least one of the surfaces of the fourth lens has at least an inflection point thereon.

11. The optical image capturing system of claim **9**, wherein at least one of the surfaces of the fifth lens has at least one inflection point thereon.

12. The optical image capturing system of claim **9**, wherein the optical image capturing system further satisfies:

$0\text{ mm}<HOS\leq 7\text{ mm}$.

13. The optical image capturing system of claim **9**, wherein the optical image capturing system further satisfies:

$0\text{ mm}<InTL\leq 6\text{ mm}$;

where InTL is a distance in parallel with the optical axis between the object-side surface of the first lens and the image-side surface of the fifth lens.

14. The optical image capturing system of claim **9**, wherein the optical image capturing system further satisfies:

$0\text{ mm}<\Sigma TP\leq 5\text{ mm}$;

where ΣTP is a sum of central thicknesses of the lenses, which have refractive power, on the optical axis.

15. The optical image capturing system of claim **9**, wherein the optical image capturing system further satisfies:

$0<IN12/f\leq 0.2$;

where IN12 is a distance on the optical axis between the first lens and the second lens.

16. The optical image capturing system of claim **9**, wherein the optical image capturing system further satisfies:

$0.01\leq f1/(f1+f3)\leq 0.9$.

17. The optical image capturing system of claim **9**, wherein the optical image capturing system further satisfies:

$0<|f/f1|\leq 2$;

$0<|f/f2|\leq 2$;

$0<|f/f3|\leq 3$;

$0<|f/f4|\leq 3$; and

$0<|f/f5|\leq 3$.

18. An optical image capturing system, in order along an optical axis from an object side to an image side, comprising:

a first lens having positive refractive power;

a second lens having refractive power;

a third lens having refractive power;

a fourth lens having negative refractive power;

a fifth lens having negative refractive power, and having at least an inflection point on an image-side surface, which faces the image side, and an object-side surface, which faces the object side, respectively, wherein at least one surface between the image-side surface and the object-side surface thereof has at least an inflection point; and

an image plane;

wherein the optical image capturing system consists of the five lenses having refractive power; the object-side surface and the image-side surface of the fifth lens are aspheric surfaces; at least one lens between the third lens and the fourth lens has at least one inflection point on at least one of the surfaces thereof;

wherein the optical image capturing system satisfies:

$1.2\leq f/HEP\leq 2.8$;

$0.4\leq|\tan(HAF)|\leq 3.0$;

$0.5\leq HOS/f\leq 3.0$;

$|TDT|<60\%$; and

$|ODT|\leq 50\%$;

where f1, f2, f3, f4, and f5 are focal lengths of the first lens to the fifth lens, respectively; f is a focal length of the optical image capturing system; HEP is an entrance pupil diameter of the optical image capturing system; HAF is a half of a view angle of the optical image capturing system; HOS is a distance in parallel with the optical axis between an object-side surface, which face the object side, of the first lens and the image plane; TDT is a TV distortion; and ODT is an optical distortion;

wherein the fifth lens has at least an inflection point on each surface thereof; and the optical image capturing system further satisfies:

$0.01\leq f1/(f1+f3)\leq 0.9$; and

$0.01\leq f5/(f2+f4+f5)\leq 0.95$.

19. The optical image capturing system of claim **18**, wherein each of the inflection points in the optical image capturing system further satisfies:

$0\text{ mm}<HIF\leq 5\text{ mm}$;

where HIF is a distance perpendicular to the optical axis between said inflection point and the optical axis.

20. The optical image capturing system of claim **18**, wherein the optical image capturing system further satisfies:

$0.6\leq InTL/HOS\leq 0.9$;

where InTL is a distance in parallel with the optical axis between the object-side surface of the first lens and the image-side surface of the fifth lens.

21. The optical image capturing system of claim **18**, wherein the optical image capturing system further satisfies:

$0.45<\Sigma TP/InTL\leq 0.95$;

where ΣTP is a sum of central thicknesses of the lenses, which have refractive power, on the optical axis; and

InTL is a distance between the object-side surface of the first lens and the image-side surface of the fifth lens.

22. The optical image capturing system of claim **18**, further comprising an aperture and an image sensor on the image plane, wherein the optical image capturing system further satisfies:

$$0.5 \leq InS/HOS \leq 1.1;$$

where InS is a distance in parallel with the optical axis between the aperture and the image plane.

* * * * *